A MANAGEMENT INFORMATION SYSTEM FOR UTILITIES MANAGEMENT IN THE NAVY

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THESIS

A MANAGEMENT INFORMATION SYSTEM
FOR
UTILITIES MANAGEMENT IN THE NAVY

by

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A Management Information System for Utilities Management in the Navy

by

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ABSTRACT

Severe demands have been placed on available, low-cost energy sources and the result has been evidenced by rapidly increasing costs for utilities services. Consequently, utilities managers must have an efficient Management Information System (MIS) that will satisfy managerial information needs to assist in sound decision making. This thesis considers the various interpretations and purposes of information systems and emphasizes the close reliance on information for management planning and controlling. The existing procedures for utilities data collection, relating to quantities and costs, are analyzed with respect to complexities and shortcomings. A totally integrated MIS to aid in facilities management is determined to have promising potential. A proposed Utilities MIS is extracted from a total, complicated system and presented as a simplified version that is in consonance with the current environment.

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I. INTRODUCTION

A. MANAGEMENT RESPONSIBILITY

All managers, whether employed by private industry or in government service, acting in a civilian or military capacity, are obligated to render decisions that efficiently promote organizational objectives and goals. In the process of striving for the optimal decisions, the management professional must have adequate tools with which he pursues the elusive best course of action. Current management credos have shifted from the attributes of experience and intuition and tend to emphasize data gathering and processing data into information that is thoroughly analyzed and forms the basis for management decisions. It is an academic question as to what relative weights should be placed on management experience, intuition or information. The information aspect of management will be specifically treated in this paper, while still retaining the perspective that all three of these managerial elements must be blended together in the composition of an effective, modern manager. Without this broad base, the model manager is unable to achieve full potential in the discharge of responsibilities to stockholders or the public.

The active manager may have the inclination but seldom the free time to analyze and clearly delineate his information needs. This paper will attempt to define objectively for the utilities manager an information format that provides utilities information in an economical and timely fashion. In most cases, the availability of information has been the result of previous management decisions or dictated by higher management levels. Seldom does the opportunity present itself for the manager to initiate new information systems. The obvious recourse is to review the existing systems that supply information with the objective to modify,

expand or delete as necessary to purify the system into a productive instrument. The delicate balance between sufficient information as contrasted to a deficiency or an over abundance must be reviewed periodically to ensure that the information resources of an organization are adjusted to a fine degree. To do less would be to abrogate the responsibility placed with management.

B. BACKGROUND

The Department of Defense (DOD) has current annual expenditures in excess of $3 billion for the maintenance, repair and operation of an over $40 billion in facilities inventory at over 800 major and several thousand minor military installations. The in-house work force of 200,000 people support a base population of around 5 million people.[1] Faced with escalating costs in utilities, material and labor, concentration must be applied on protecting the investment and ensuring that facilities are operated and maintained in such a manner that they will properly support the DOD mission in the most economical manner.

The operation and maintenance of utilities support alone at DOD installations currently approximates $1 billion annually with around a third of that spent for outside purchase of utilities.[2] During the past decade there has been an average increase in utilities consumption of seven percent per year. Unit costs are currently increasing at twelve percent in addition to consumption. Present forecasting for the immediate future indicate that energy costs will be significantly higher regardless of the

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[1] DOD Real Property Maintenance Council, Fourth DOD Real Property Maintenance Conference, 29-31 January 1974, p. 1.

[2] Ibid, p. 25.

fuel or synthetic fuel that is used and regardless of whether it is supplied from a foreign or domestic source.

On 29 June 1973, the President directed that agencies of the Federal Government would reduce their energy demands by seven percent during FY 1974. When viewed in light of the fact that consumption has traditionally increased each year, management is faced with a formidable problem. The problem will not be solved by issuing repetitive directives down the chain of command or by limiting all users to 93 percent of their previous year utilization or by arbitrarily eliminating seven percent of the users. There is no one single easy solution to this problem. However to be truly effective in FY 1974 and for future years, it is essential that management have at its disposal the necessary information to identify problem areas, suggest alternative solutions and evaluate performance toward established and attainable objectives.

C. PROBLEM STATEMENT

A Utilities Management Information System (UMIS) must provide the means to management that are necessary to effectively manage the utility plants (including purchased utilities) and distribution systems at the operating activity. The purpose of this paper is to review what is currently available to the Navy Utilities Manager in the form of data or information, determine what typical Management Information Systems are intended to provide, and to suggest modifications or improvements that will assist managers toward the goal of efficient utilities management. Troubled with the current and foreseeable future problems of increased costs and austere budgets, it becomes mandatory that the best of newly developed management techniques be incorporated into the utilities management effort. Current MIS, as employed within DOD, deal mainly with cost

control, which represents just one aspect of managerial concern. The present reporting system for utilities must be reviewed and analyzed to arrive at the most effective MIS that can be offered to management in order to attain established objectives and goals.

D. SCOPE

Managers have been inundated by computer salesmen with the enticing prospect of a single management information system called the Total System, the Total Management Information System or simply MIS. This concept is denied by Mr. John Dearden who states "The notion that a company can and ought to have an expert (or a group of experts) create for it a single completely integrated super-system, an MIS, to help it govern every aspect of its activity is absurd."[3]

The utilities management program is of sufficient complexity and magnitude to deserve singular attention as a unique management system. The utilities management system should not be encumbered by expanding the system to include other allied systems, such as real property maintenance; or to place an additional burden of attempting a fully automated management system to include such refinements as work scheduling.

The UMIS, as any other MIS, must provide timely and accurate information. Grandiose schemes to provide all information to all users usually attempt to achieve this idealistic goal by sacrificing responsiveness, which ultimately destroys usefulness.

The scope will be limited to a review and analysis of the present Utilities Management System and will concentrate on the informational aspects that pertain to the performance and the state of the utility system.

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[3]Dearden, John, "MIS is a Mirage" Harvard Business Review, Vol. 12, Jan.-Feb. 1972, p. 90.

The provision of information on the effectiveness of service utilization and operation efficiency will receive attention, as well as the extent to which consumers utilize available utility services.

E. OBJECTIVES

A review of the current reporting system should disclose, when compared to the characteristics inherent in general models for MIS, those areas that require revision. The ultimate UMIS should provide the following:[4]

1. Standardized procedures for the collection of data to insure reliability and accuracy.

2. Simple and accurate methods of converting data into useful information to managers.

3. Refinement of existing performance standards and potential development of new standards.

4. A comprehensive display of operation and maintenance activities of major utility systems.

5. Indicators revealing significant exceptions of actual and planned performance.

6. Data for establishment and maintenance of accurate and current utility rates for users.

7. Effectiveness reporting of the management effort to higher authority.

8. Data on the magnitude of utilities operation.

9. Raw data for inclusion in a historical data bank.

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[4] Dept. of the Navy, Naval Facilities Engineering Command, Draft-Public Works Department Management System (NAVFAC P-428) Vol. 4, Part 1, July 1971, pp. 1-2.

10. Indentifying excessive utilities usage.

11. A quick, easy and accurate method of establishing usage goals.

12. More equitable and uniform distribution of utility expenses.

13. Potential for ADP application for establishing controls.

A refined UMIS may provide all or portions of the above in varying degrees. The ultimate objective is to furnish acceptable levels of information in context with time, manpower, data availability and monetary constraints.

F. METHODS

Current DOD and Navy Instructions are reviewed in order to assess the existing reporting systems. Examination of the most recent literature and official government documents reveals the philosophy underlying management information systems. Periodicals contribute diverse viewpoints that are currently under debate. Book publications appear repetitive although reflecting a sense of constancy in this rapidly changing field. Personal interviews with knowledgeable managers, specializing in information systems and utilities services, contribute background as perceived by personnel at the operating level (Public Works Officers and Staffs), the middle management level (Naval Facilities Engineering Command Engineering Field Divisions), and the upper management level (Headquarters Levels in Washington, D.C.). Improvement studies conducted by interested parties, but not implemented to date, provide the genesis of ideas for future development. The personal experiences and observations of the author bias the presentation, but cannot be excluded as they inject a sense of pragmatism emanating from tours as Shops Engineer, Assistant Public Works Officer, Public Works Officer and assignment with the Facilities Management Branch on the staff of CINCPACFLT.

G. ORGANIZATION

This thesis paper traces through the current methods of Utilities Management Information Systems within the Navy, in contrast to the generally accepted principles of management information systems, in order to develop conclusions that form the basis for potentially constructive recommendations. In addition to a generalized discussion of current energy problems, Chapter I has developed the basic groundwork on which the thesis will center.

Chapter II reviews the Utilities Cost Analysis Report (UCAR), the present Navy reporting system for operation and maintenance of utilities. This chapter discusses the methods of data gathering and presentation with a brief comment on the strengths and weaknesses of UCAR.

Chapter III evaluates current principles of Management Information Systems noting the various approaches employed in this relatively young and undeveloped management field.

Chapter IV scans the role of the manager and the managerial theories that have been proposed for his guidance. The important managerial functions of planning and control are discussed in regard to the relationship with information as provided by a Management Information System.

Chapter V reviews the current needs and demands for utilities management improvements and considers a proposed direction for information systems. The chapter concludes with a simplified proposal based on a Data Module that can serve as an effective Utilities Management Information System.

Each chapter is summarized in general by Chapter VI. A conclusion is stated that advocates the implementation of the Data Module, presented in the latter part of Chapter V, as the proposed Utilities Management Information System (UMIS).

II. THE NAVY UCAR SYSTEM

A. BACKGROUND

In past years, the average industrial consumer of utilities has taken for granted that the capability for generating utilities services was unlimited, with the only constraint being that the cost incurred through usage should be minimized. Thus, the management effort was primarily centered around utilities conservation in order to reduce operating costs. The current energy crisis resulting from oil shortages has vividly demonstrated that even though adequate funds are available to pay for increased costs of utilities, there is increasing evidence that desired utilities may not be available for purchase. Utilities, as used in this paper, represent the state or quality of being useful in the nature of a public utility. The process of supplying an essential utility (electricity, steam and hot water, potable and nonpotable water, sewage and industrial waste treatment, air conditioning, gas are major utilities services) to the general public must now be closely examined by all producers and consumers.

According to the Wall Street Journal, until recently, energy was so cheap that out of each dollar the average manufacturer spent on costs, only five cents went for energy.[5] Businessmen felt it didn't pay to conserve energy in that the value of the energy saved would often have been less than the cost of trying to save it. In the case of electricity, steam, hot water, and gas the increase in energy costs are passed along

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[5] Lehner, Urban C., Manufacturers Save Millions by Increasing Efficiency in Energy, Wall Street Journal, 11 March 1974, p. 1.

directly, while for the other utilities previously mentioned, energy costs are a major contributor to utilities costs. Since energy costs and energy availability control in some degree all utilities costs, it becomes readily apparent that control measures that were not justifiable when costs were 20 cents per million Btu now seem justifiable when costs have escalated to $1 per million Btu.[6]

Fortunately, the U. S. Navy has established a reporting system that provides management with utilities data. Initial implementation was in 1956 as the Utilities Conservation Program. The early program included only the collecting of technical data and costs. By 1963, the program had been refined to include new cost collection and an analysis system developed by private consulting firms. Further developments have improved the system to reflect additional requirements, and further refinements have been instituted during the past ten years.

The primary purpose of a Management Information System (MIS) is to provide management within an organization with information that reduces the degree of uncertainty in the decision process. The information may be used at the three management levels of strategic planning (top management), management control (middle management) or operating control (lower management). The information can be classified similarly for decision making as to either strategical, tactical or technical information. For purposes of this paper, strategic planning is viewed as the efforts of top management (CNO, Chief of Naval Material, Systems Commands and Major Claimants); management control encompasses middle management (Naval Districts, Type Commanders, Engineering Field Divisions and Naval Shore Activities); and operating control or lower management overlaps middle

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[6] Ibid., p. 25.

management in that Naval Shore Activities are the primary operating levels in addition to their middle management role. The paper focuses on the Naval Shore Activity participation in the Utilities Cost Analysis Report (UCAR) and attempts to determine whether the system functions effectively as a Management Information System. Further an analysis of the UCAR system will attempt to arrive at conclusions and recommendations to improve the system toward a more valuable MIS.

B. UCAR OBJECTIVES AND PROCEDURES

The UCAR system attempts to achieve the following:

1. Provide data for analysis of utility quantitative work units in addition to collecting expenses for utility operations and maintenance segregated by the individual utility system involved. The UCAR is a management tool to determine actual costs of operating and maintaining a utility system at a Naval installation and should permit the detection of areas to investigate for cost reductions or operational problems in addition to providing data to establish activity rates for the sale of utility services.

2. Establish a reporting system for effective management control that is both timely and accurate to allow expeditious handling of problems arising in the normal course of operations. The areas of interest comprise:

a. Comparison of actual operations against planned operations.

b. Definition of problem areas and the suggestion of opportunities for improvement.

c. Data base information to be used as input for the preparation of future plans.

d. Assistance in the evaluation of operating performance.

3. Display data uniformly in order that operating results may be compared at an installation for different like-periods or compared for the same period between separate installations.[7]

In reviewing the above, it can be seen that the three management responsibilities of planning, operating and control are involved and the subsystems of financial, production/operations, marketing (sale of utilities) become interrelated. This type of information gathering system centers primarily on: action vs. non-action, recurring vs. non-recurring and historical vs. future types of information classifications.

In evaluating how well the above purposes are satisfied it is necessary to review the system inputs and transactions in context with the information flow within the system in order to generate outputs and reports that form the basis for the management decision process.

In order to gain an appreciation for the final results that are generated by the UCAR system it is necessary to identify the inputs/transactions that form the raw data and further, to trace this data through the system to see how it may be transformed into useful information.

Within the typical Naval Shore Activity, the major departments involved in the UCAR system are the Public Works Dept., Supply Dept. and the Comptroller as shown in Figure 1 of Appendix A. Utilities operations are authorized by Job Orders which collect material and labor costs necessary to maintain and operate each utility generation and distribution system. Initial inputs to the system are on a daily basis. The Supply Dept. provides material costs and the Public Works Dept. provides labor charges by Labor Distribution Cards to the Machine Records Unit. (Steps 1 and 2).

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[7]Naval Facilities Engineering Command, Western Division, Guide for Utilities Cost Analysis Report, West Div. Inst. 11300.4, 16 April 1971, p. 1.

The data is collected and each month a Tab Report by job order and functional account is prepared and furnished to the Comptroller/Fiscal Officer (Step 3). At this point considerable data must be supplied by the Public Works Dept. during each month (Step 4). This data is comprised of the Utilities Feeder Data Report (NAVCOMPT Form 2126), budget data, and unit amounts of utilities sold to customers (reimbursables). With the accumulation of this data input, the Comptroller is able to complete the Utilities Cost Analysis Report (NAVCOMPT Form 2127) with the exception of unit cost target delivered and produced. The advance copy of the UCAR is furnished to the Public Works Dept. (Step 5) for provision of the lacking data. At this time the rough report is reviewed for major discrepencies and returned to the Comptroller with the complete data (Step 6). The Comptroller is now able to review the UCAR in its entirety, authenticate and distribute copies to various users (Step 7). Distribution of the UCAR is based on the level of the annual cost of utilities. For activities that have consumption over $500,000 in utilities costs, reports are monthly, quarterly and annually. For lesser amounts, such as under $100,000 reports are only required on an annual basis. Distribution internally is as specified by the local command and external distribution is to the Major Claimant, Engineering Field Division and to the Naval Facilities Engineering Command.

The major contributor of inputs and beneficiary of results is the Public Works Dept. To comprehend the information flow in the UCAR system it is enlightening to trace the data flow for a particular utility system through the Public Works Dept. A separate UCAR is prepared for each system which is operated independently of the major utility system of an activity. Typically, a steam production and distribution system operated only to provide steam for ships would be reported and identified separately

from other steam plant systems. Whereas, a series of steam plants interconnected into a single distribution system serving not only ships but other facilities, would be reported as a single system by the activity producing the steam.

Figure 2 of Appendix A illustrates a sample UCAR (NAVCOMP Form 2127) which is utilized jointly for capturing inputs in summary form and displaying results after necessary calculations. In principle, the Utilities Feeder Data Report (NAVCOMPT Form 2126) is employed to record quantitative data within the Public Works Dept. and is shown as Figure 3 of Appendix A. Many activities exclude the Feeder Report and simply input the required data to the Comptroller on a rough UCAR worksheet. Figure 4 of Appendix A shows the data flow within the Public Works Dept. that permits preparation of the Feeder Report. The Operating Section of the Utilities Division maintains daily, weekly and monthly operating logs which record utilities quantities that are produced or purchased and constitute Section I of the UCAR (see Figure 2 of Appendix A). This raw data is transmitted as Step 1 of Figure 4 of Appendix A to the Utilities Division Control Section. Additional data pertaining to the Interutility Transfers of Section II of the UCAR (Cost of Production and Purchase) is added and forwarded by Step 2 to the Engineering Division. Within the Engineering Division, various calculations and engineering estimates are performed to determine lines 7, 13 and 16, which pertain to production/purchase quantity targets, rated capacity of production plants or supply sources, and fuel quantity target.[8] The accumulated quantities and targets are transmitted by Step 3 to the Public Works Officer, who combines the data with the budget item figures provided by Step 4 from the

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[8]Naval Facilities Engineering Command Utility Targets, Maintenance and Operations Manual #303, Washington, D.C., May 1972.

Administrative Division (columns 17 and 19 for line items 17 through 45). The entire package is reviewed by the Public Works Officer and forwarded to the Comptroller by Step 5 for final processing of the UCAR. During the data input stage it is extremely critical that correct cost accounting procedures be followed closely. The initial starting point is the selection of the appropriate cost accounts as stipulated by the Navy Comptroller that apply to a particular job.[9] If the cognizant supervisor selects the correct cost account, then the proper costs will be presented in the proper locations on the UCAR. If not, then the principal of "GIGO" (Garbage in-Garbage out) will prevail and the dangers of misinformation will manifest themselves.

Study of the UCAR (NAVCOMPT Form 2127) reveals a mass of figures that seem to bear little relationship to providing management with the relevant data required to make timely decisions. Figure 5 of Appendix A attempts to relate line item quantities to a typical utility operation. In this case, a steam generating plant is charted in order to integrate the input/outputs to the costs involved and compare quantities and costs against quantity and unit cost targets. The initial phase of the process is to develop the quantity of heat made available to all users in terms of 10^6 Btu (British Termal Units). The starting point is the net plant production, which is the total amount produced by generating units less the quantities used in production. To this net plant amount is added any amounts that may be purchased from other Navy sources or outside civilian public utilities sources (in the case of the electrical utilities, many Naval Activities perform no generation, other than for emergency usage,

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[9]Office of the Comptroller, Dept. of Navy, Navy Comptroller Manual, NAVEXOS P-100, Vol. 3, Wash., D.C., 2 February 1972.

and purchase from civilian agencies the entire amount consumed). This total quantity produced and purchased is evaluated against a calculated target figure to determine efficiency of operation and wastage amounts. Two additional adjustments are required to arrive at the Net Quantity Delivered. These are comprised of Interutility Transfers (i.e., electricity, water, etc.) which are quantities required from other owned utility systems to run the plant; and, the quantity lost in the distribution system to the users. Fuel quantities to run the system are also determined in Section I, which when completed provides quantities used and produced in the particular utility system (denoted by circles in Figure 5 of Appendix A).

Section II and III of the UCAR collect costs for production/purchase and distribution of the utility. Costs are identified to operations, maintenance, overhead and interutility transfers. Further breakdowns indicate costs for labor, material, fuel and contract costs. These costs are shown at their various points of entry on Figure 5 of Appendix A as hexagons. Unit costs (triangles) and unit cost targets (squares) are developed and are used for evaluation of the system when the report is finalized.

The result of the foregoing is that Section I of the UCAR furnishes quantitative information on the production and purchase of utility services. Section II reports expenses of producing utility services and products. Section III delineates the direct and overhead expenses for the utility distribution systems, and Section IV accumulates the total cost of production, purchases and distribution for each utility. In summary, after completion of the first four sections of the UCAR, the data gathering and input stage is essentially complete. Armed with the above data, the objective is then to present the results in an informative display,

which can be helpful to management in executing responsibilities. Although it appears the data input is excessively comprehensive, it should be evident that such an elaborate procedure is necessary to ensure the uniform preparation and processing that will culminate in decision making guidance that the UCAR envisions for all its users.

C. RESULTS

The data gathering process is of no value unless information can be developed by data processing, the resulting information communicated and management action initiated based on the information generated. Section V has information as to actual unit cost to deliver, produce and purchase utilities, the established activity rates and net gain or loss for the period. This section contains information that is similar to the "bottom line" of a business income statement. It is here that operating results are compared against computed target figures. An activity rate is determined that forms the basis for customer billing to recover from those tenant users that are required to adequately reimburse the lead activity for utility services that the tenant consumes. Finally, a Net Gain or Loss is determined that assists in adjusting the activity rates to ensure equitable treatment of consumers. Unlike business operations, it is not the goal to garner financial gains in this area but to break even and require that users deriving funds from other sources than the producing activity pay their fair share of utilities costs. Otherwise, the utility producing lead activity would unnecessarily carry the cost burden when it has not budgeted or been funded to provide an underpriced utility.

Section VI reports cumulative amounts for the fiscal year to date for units produced and consumed. This provides a ready check during the year against the activity financial plan and can highlight areas that are destined for future difficulties due to detected trends.

Section VII reflects distributed costs and is used by industrial-commercial activities.[10] Essentially, it summarizes expenses recovered from customers in addition to activity expenses. Section VIII is an attempt to gather all costs of a special nature to satisfy accounting procedures and may be regarded as a statistical charge. It attempts to capture the military labor costs expended for operation and maintenance of the production and distribution of utilities. Most industrial-commercial Naval Activities would not utilize military labor. Additionally, under Section VIII, statistical costs for operation and maintenance equipment used solely for utilities are posted.

Of particular importance are columns 16 through 20 of the UCAR. These columns present minimal timely management analysis to facilitate prompt and effective management action or investigation of apparent problems. Regardless of the source of funds, these columns attempt to portray the actual results backgrounded against budgeted amounts. Major deviations detected should be explored while there is still time to take corrective action or to adjust plans.

Since the UCAR system has been in operation since 1964, the formulation of a data base has had a decade of growth. Unfortunately much of this data base is not readily available at intermediate levels (next echelons above the activities) where it could be of service. At the activity level the data and reports are accumulated for prior years and usually are not actively employed in the management of the systems. At the type commander or major claimant level, the reports are used mainly for financial control and budgeting purposes. A requirement exists at the intermediate

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[10] Office of the Comptroller, Dept. of the Navy, Navy Industrial Fund Handbook, Washington, D.C.

level for a viable data base that can be manipulated to provide management information for decision making in areas that have common problems.

A last benefit is that the results of the UCAR provide an input to various other reports. The Department of Defense Installation and Logistics Report uses data from the UCAR. A companion report to the UCAR is the Maintenance Cost Analysis Report (MCAR), which utilizes data portions directly from the UCAR. Futureutilities project designs and selections should rely heavily on data provided in the UCAR. Finally, the personnel assigned to Utilities Conservation Survey and Management Assistance Teams, emanating from echelons above the activity, utilize the UCAR to determine areas of future economies and to ascertain cost reduction surveys.

D. ANALYSIS OF RESULTS

Management is expected to go much further in the usage of the UCAR than to merely review the figures shown on the UCAR itself. The utilities management decision process does not revolve around any one man or any particular level of management. A plant supervisor is in a position to take immediate action at the working level as a result of costs incurred by his work force. Even though he may not be able to directly control quantities produced or purchased, he is still in an important position to control costs of production or distribution. The Utilities Division Supervisor can evaluate results of his separate utilities systems and in conjunction with the Engineering Director seek opportunities to reduce costs, improve service or better integrate the different services provided. The Public Works Officer upon review of the UCAR can grasp how well his department is meeting the objectives of the activity and the trend of his costs. In conjunction with the Comptroller it may be necessary to adjust current year and future year financial planning in order to provide

sufficient operating resources to carry out the activity mission. With the results from the UCAR, the Comptroller and PWO can approach the Commanding Officer with concrete data to support a reallocation of activity funds required to support desired levels of effort. Future budgeting requests contain more validity when supported by quantities produced and unit costs of each utility services.

Type Commanders and Major Claimants are better able to allocate the utility dollar based on past performances and verified future needs. Management decisions at this level can be improved by a more detailed analysis and comparison of like variables for different activities. Thorough analysis at this level is essential if fund requests are to be honored at the CNO level. CNO personnel are under constant pressure to eliminate ineffective units in Navy commands. Marginal fleet operating units have been reduced drastically in recent years and inefficient Naval Activities should also receive the same close scrutiny. This should lead to decisions either to eliminate those activities that are not producing efficiently or to seriously question their current level of operations. Only with the assistance of a good MIS will activities be better able to justify their contribution to the total Navy goals.

The mechanical submittal of the UCAR does not fulfill management's responsibilities. The raw data is necessary but managerial steps must be taken beyond data accumulation to develop meaningful parameters that can be allied with management experience and intuition to meet a goal of MIS to reduce the degree of uncertainty in decision making. Analysis ratios that measure various items from the UCAR should be developed that provide constructive guidance and pinpoint potential problem areas requiring action

or close monitoring.[11] Relevent ratios must pertain to the activity operations and be comparable to historical results, other activities or industry standards. These ratios must be of value and not be accumulated to provide "window dressing" for display purposes. They should not require an inordinate expenditure of time that does not equate favorably with the benefit of the results. Trends in purchased utilities quantities, maximum demands, purchased utility costs, delivered unit costs and a myriad of other items are easily charted on a monthly, quarterly or annual basis. If these charts show no meaningful trends or do not provide a firm basis for action or investigation, then they should be abandoned and the effort devoted to the areas that have immediate payoff or a firm potential for future opportunities. General areas that offer analytical opportunities for management improvement consist of ratios dealing with labor, materials and purchases. From a budget viewpoint there are trends, comparisons of actual versus planned levels, returns from sales and gains or losses. Statistical review could encompass staffing ratios, purchased costs, production costs, maintenance costs and overhead costs. All activities cannot satisfactorily monitor all these areas, but at least annually, all areas should be summarily reviewed and the most pertinent and profitable areas isolated and observed closely during future time periods.

E. FUTURE DIRECTIONS

The cost and the amount of utilities consumed by Naval Activities must be evaluated differently from previous approaches. Until the present it was assumed that it is a necessary housekeeping function and must be maintained at any cost in order to meet an activity mission. A rise in costs

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[11] Naval Facilities Engineering Command, Utilities Management Manual, Publication #96, Washington, D.C., June 1964.

or a rise in consumption is not inevitable. Utilities planning should not proceed on a basis that projections are based on a stipulated percentage annual rise in these factors. Because labor costs are rising, or that inflation continues at five to ten percent annual rate, is no reason to blindly apply such adjustment arbitrarily to utilities costs requirements. Increases in quantity consumption are not necessarily a hard fact of life but should be subjected to hard questioning. New equipment is added, but does this necessarily mean that more utilities must be consumed? Was not the new equipment purchased because it should perform some operation more efficiently or perhaps consume less utilities? What are the potentials of heavier capitalization by constructing more efficient utilities systems projects that have a corresponding reduction of manpower and a lessening of this high contributor to costs? Are we using the maximum amount of utilities produced and are we using them wisely? These questions and many others when answered will lead to intelligent management decisions. The data that can help in the answers and decisions is available in the UCAR system but is not currently being employed properly. As an MIS, the UCAR system goes part way to being the best management tool. As in any information system employed in an established organization, rarely is the opportunity provided to institute a completely new system from ground up. Such is also the case with the UCAR. The basic system has operated for ten years and has developed a satisfactory data base. The procedures are sound though much maligned by the user and persons responsible for input. The system requires a more meaningful purpose as its end objective and not simply to be a time consuming, detailed expensive report.

The UCAR most assuredly provides data, but data is not information. It will not be a management tool until it actually helps management to

better plan and control the utilities placed in its care. The report does allow the detection of areas for investigation or action if the proper variables are selected and interpreted.

The accuracy and timeliness of the UCAR are questionable. Accuracy will vary depending on the particular location and is dependent on the care taken during input stages. The timeliness is critical. Presently, mechanization has been limited to activity levels. Consolidated computer output and analysis has not been achieved. This area is being explored with potential for reward. However, at many activities, the automatic data processing has not produced output within the required time frame. This time lag diminishes the value of the report. Activity rates, as one example, are late in computation and are not adjusted in a timely fashion to permit fair recovery of resources from consumers.

The UCAR succeeds in displaying progress against plan. It does not necessarily follow that the original plan was correct. Annual plans should be revised during the current year to reflect operations in a current fashion. At present this is not being done and as a result comparisons of current operations against an old budget may be misleading.

Problem areas can be identified by virtue of the UCAR if pertinent indicators are observed over time. Most of these indicators may be calculated by simple models which are ideal for computer application. The results would be most beneficial at the intermediate management level where many activities are available for comparison under a significantly larger data base. Answers will not be provided, but the important questions will be revealed in order that the data base can be manipulated in the quest for suitable alternatives.

Early indication of problem areas is not a strong point of the UCAR as the data is accumulated over a lengthy period and current processing

time delays final output. Although substantial improvement may be difficult to achieve, the data and information available during the input stages can be useful in early detection of problems. Familiarity with early input items will allow personnel to quickly perceive when data is not in conformance with previously reported data. When this occurs, management can be alerted by these early warning signals.

Future planning in budgets and new utilities projects should rely very heavily on the UCAR. These areas comprise the heaviest utilization of the UCAR and will continue to be recipients of valuable planning information.

Evaluation of operating performance must receive more emphasis as an objective of the UCAR. Planned performance must be based on the most current information, and operating results must be evaluated against plans in a timely fashion. It is in this area that immediate results in reduced consumption and costs can be realized. Management control can be applied when management knows when and where to invest attention. A practical MIS would reveal the significant investment opportunities to management.

III. MODEL MANAGEMENT INFORMATION SYSTEMS

A. MANAGEMENT AND INFORMATION

Management information and the systems designed to accumulate and present this resource have been interpreted and defined by many authors. The interpretations and definitions vary but the entire community of authors and users agree that it must be available in order to successfully operate a going concern. Prior to proceeding into an analysis of Management Information Systems (MIS), it is necessary to distinguish between "data" and "information." Unfortunately, many managers tend to use the terms interchangeably. It is unlikely that the average businessman would use the words "cents" and "dollars" loosely. The value of the dollar is certainly one hundred times the value of the cent and is therefore more cherished. Both have value, but the dollar overwhelms the cent in relative importance. So it is with data and information, although a definite ratio is impossible to establish. Without the accumulation of pennies, there theoretically can be no availability of dollars. Without the gathering of data, information will not materialize.

Data are the little facts, building blocks, that help build the house of information. Data can also be viewed as raw materials that are invested into a management system, whether that system be one that utilizes high speed electronic processing equipment or a manual system with an employee adding a column of figures mentally to arrive at a figure for daily sales volume. In essence, data must be processed before it becomes information and becomes useful and meaningful. Data in its basic form may or may not have value to the manager. Mr. Peter Schoderbek sets data and information apart by stating that data is an accumulation of facts and

material which are to be used inferentially but have not been evaluated as to their worth to a specified individual in a particular situation.[12]

Information is a valuable company asset. It is the knowledge that has resulted from the raw material input of data after it has been properly processed, assessed and communicated. For the information to be useful to management the data input must have the attributes of quality, quantity and timeliness.[13] If such is not the case, the resultant product of information will assume the label of "misinformation," which will have a reverse effect and be detrimental to future operations.

Historically, information systems have progressed from the collection of clerical costs and the control of paperwork. The advent of the modern day computer has enabled these functions to be simplified and accelerated to produce voluminous reports in intricate detail with a many different forms of presentation, subject only to the whims of the user. However, it must be cautioned that such output does not necessarily represent information by the mere virtue of the fact that the system incorporates the use of a computer. The output may be simply a reporting system, which comprises only a portion of a strictly defined management information system. In many instances, the computer as used by management has been exploited as the means of "data begets data." Data may be disguised in many forms and its collection and rework into a different state can represent large unnecessary costs to an organization.

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[12]Schoderbek, Peter P., Management Systems (New York: McGraw-Hill Book Co., 1968), p. 3.

[13]Sanders, Donald H., Computers in Business, (New York: McGraw-Hill Book Co., 1968), p. 3.

B. MANAGEMENT INFORMATION SYSTEMS

The modern management information system must possess and transmit what the military have referred to for many years as intelligence. A review of current literature is enlightening in the varying methods used to describe what MIS really is and what it is intended to do. Even though the thoughts are presented differently, there appears to be some common threads connecting the different views.

The system as characterized by Ream should have a blend of the following characteristics:

1. It must facilitate planning and control and provide top management with a comprehensive understanding of those factors, both internal and external which influence the operations of the enterprise -- it must enable managers to carry out their delegated responsibilities in conformance with total corporate objectives.

2. It must provide performance measurement factors for all quantifiable functions, thereby furnishing management a means for a high level review of company operations.

3. It must provide the information requirements to all management levels for operational control of the entire organization structure.

4. It must provide the information necessary for the continued development and application of advanced scientific-management techniques.

5. It must be flexible in nature, capable of changing in the shifting socio-economic and political environment in which a dynamic business battles to survive.[14]

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[14] Ream, Norman J., "The Need for Compact Management Intelligence," Management Control Systems, (New York: John Wiley & Sons, 1960) p. 92.

As a broad definition by Aharon G. Beged-Dov, MIS provides economically the information needed for planning, direction, evaluation, coordination and control of the firm. A well-designed information system should:

1. Provide each level and position of management with all the information that can be used in the conduct of each manager's job.

2. Filter the information so that each level and position of management actually receives only the information it can and must act on.

3. Provide information to the manager only when action is possible and appropriate.

4. Provide information that is up to date in a form that is easily understood and digested by the manager.[15]

The above guides stress the aspect of relevent and timely information provided in a clear fashion to those managers who must make decisions.

A MIS, according to Mr. Bertram A. Colbert, is an organized method of providing each manager with all the data and only those data which he needs for decision, when he needs them, and in a form which aids his understanding and stimulates his action. Such a system would:

1. Consider the full effect of a decision in advance by supplying complete, accurate and timely data for use in the planning and decision making process.

2. Eliminate from the planning and decision making processes the problems associated with the use of inconsistent and incomplete data by providing a means for preparing and presenting information in a uniform manner.

3. Use common data and methods in the preparation of long-range and short term plans.

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[15] Beged-Dov, Aharon G., "An Overview of Management Science and Information Systems," Management Science, Vol. 13, No. 12, August 1967, p. 58.

4. Identify, structure and quantify significant past relationships and forecast future relationships through the use of advanced mathematical techniques in analyzing data.

5. Merge financial and production data to produce significant measures of performance to facilitate control of present costs and to facilitate planning decisions with minimum processing of data.

6. Recognize the need of all corporate units so that the requirements of each are met with a minimum of duplication while serving the corporation as a whole.

7. Reduce the time and volume of information required to make decisions by reporting to each level of management only necessary degrees of detail and usually only the exception from the standard or norm.

8. Utilize personnel and data effectively so that the optimum in speed and accuracy is achieved at the lowest cost.

9. Require that the data be presented to those responsible for the decision making and planning process in a form which minimizes the need for anlaysis and interpretation.

10. Provide flexibility and adaptability to change.[16]

The above quite succinctly itemizes the information system as an internal mechanism for direction and control, and under ideal situations it should aid the company's response to all external events that could affect it.

Many management information systems have been designed by people who "think" and the results are Thinking Men's Systems rather than action oriented systems. Mr. Richard Werling is critical of the present MIS as far as they go and criticizes that these systems fail to meet their prime reason for existence as they fail to provide action-oriented information,

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[16] Colbert, Bertram A., "Pathway to Profit: The Management Information System," Management Services, Sept.-Oct. 1967, p. 59.

information that enables responsible individuals to identify needs for action, and assists in accomplishing those actions. The ideal MIS must emphasize action based on the timely presentation of data, predigested and tailored to the action needs of responsible individuals. He further states that other MIS characteristics include:

1. Concern with forecasts and the future, rather than with history.

2. Indication as to which of several actions is appropriate.

3. Tailoring the information presentation to the use to which it will be put, favoring short simple reports telling what is needed by the recipient to support his actions, and uncluttered by extraneous information.

4. Using computer-based equipment when there is a clear economic advantage, but recognizing that informal personal contact, telephone calls, handwritten notes - when satisfactory - may be economically superior.[17]

These requirements represent a practical approach to MIS but ingest significant forecasting and decision making ability, which may not be easily attainable with economical information systems under the present state of the art.

Mr. Miller in attempting to arrive at conceptual models for determining information requirements agrees with the characteristics of an MIS as previously cited by Mr. Beged-Dov only to add that it should provide any form of analysis, data or information whenever it is requested. This add-on on the surface appears minor but can become extremely expensive in practice if such requests are uncontrolled. This definition would include a collection of procedures, equipment and persons associated together for the purpose of providing managers, who have the authority to make decisions

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[17] Werling, Richard, "Action-Oriented Information Systems," Datamation, June 1967, p. 59.

that commit the firm or its resources, with descriptions of the elements relevant to the performance of their function. Or simply stated, it is a means of providing to the people who need it, information to guide them in the conduct of business.[18] As is the case with most authors attempting to define MIS, the above provides both the comprehensive and the pocket-size definitions, but essentially the Miller definition correlates the entire structure within the organization that may bear on the information problem.

Management information systems are usually described by the characteristics inherent to the system. The engineering-oriented descriptive "specifications" is used by Mr. James Becker, who also prefers the term "total information system," which he describes as "a medium for recording all significant actions of a company and logically assembling and screening them so they can be quickly interpreted and easily controlled."[19] His specifications for the total information system must:

1. Deliver information when it is needed.
2. Provide for total horizontal distribution of information.
3. Filter vertical distribution of information.
4. Readily assemble information for special reports.
5. Execute through its internal logic as many controls as feasible.[20]

The specifications listed would aptly apply to a simple information system as well as to a total information system and closely parallel the characteristics enumerated by other authorities.

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[18] Miller, James C., "Conceptual Models for Determining Information Requirements," Proceedings-Spring Joint Computer Conference, 1964, p. 609.

[19] Becker, James L., "Planning the Total Information System," RCA Service Company, 21 January 1965, p. 66.

[20] Ibid., p. 67.

Mr. John Dearden strongly objects to the concept of a totally integrated information system which he provides the definition as "anything from our old friend 'integrated data processing' to the ultimate automated business."[21] It is his belief that systems are organized as either horizontally, classified by the type of work performed; or vertically, classified by the kind of information handled, such as financial, personnel and logistics data.[22] In a later chapter it will be seen that a Utilities Management Information System proposes to bridge between the financial and logistics classification of information systems.

The simple definition that "the basic purpose of the Management Information System is to assist in the decision making process" is submitted by Mr. William R. Trotter, who further states that the MIS must provide management with the following:

1. Identification of activities requiring management attention.

2. Information adequate to identify the "problem areas" through requesting additional details or initiating special studies.

3. Measurement of the degree of attainment against goals or objectives.

4. Methods of measuring the effectiveness of key positions.

5. Environment to establish mutual "standards" or goals, for comparison with accomplishment, throughout all levels of management.[23]

An interesting evolution is pointed out by Mr. Trotter that perhaps best explains the confusion among managers between data and information

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[21] Dearden, John, "How to Organize Information Systems," Harvard Business Review, January 1965, p. 65.

[22] Ibid., pp. 67-71.

[23] Trotter, William R., "Organizing a Management Information System," S.A.M. Advanced Management Journal, April 1969, pp. 42-43.

as mentioned earlier in this paper. He contends that most companies go through a normal evolution in their reporting over a considerable period of time as they develop their information system. The evolution begins with raw data reports, which are simple statements of results, and progress to historical reports where the format shows a comparison of actual results, and the results obtained during a previous period. The next step is the plan vs. actual report where actuals can be compared by a variance from the plan. Finally, the theoretical culmination, is the exception report where only the plan and actual results are shown when the variance between them exceeds a given limit, whether good or bad.[24] The last stage has the merits of an information system, but unfortunately, is seldom encountered in actual practice.

Mr. Zani argues that such development of an MIS from the "bottom up" is wrong as they have been spun off as by-products of the process of automating or improving existing systems within a company. He states a MIS "should be designed to focus on the critical tasks and decisions made within an organization and to provide the kind of information that the manager needs to perform those tasks and make those decisions.[25] He believes that MIS should be oriented to decision making and that the factors that should structure the characteristics of information provided to management are:

1. Opportunities and risk
2. Company strategy
3. Company structure
4. Management and decision making process
5. Available technology

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[24]Ibid., pp. 43-44.

[25]Zani, William M., "Blueprint for MIS," Harvard Business Review, Nov.-Dec. 1970, p. 95.

6. Available information sources[26]

Where words will not suffice, some authors have taken the path of providing diagrams to support their definition of MIS. Dr. Martino presents the chart shown as Figure 6, Appendix A while defining MIS as a system that has the following attributes:

1. Measures the impact of decisions - either before or after they are made.

2. Measures the environment - because we can neither control nor forecast the effect of changing external circumstances.

3. Reacts in an appropriate time frame - to enable us to learn of the developments of potential trouble areas in time to take action.[27]

The generality of the above definition serves to encompass a wide variety of interpretations. The core of the definition evolves around measurement and timeliness. The chart serves to expand the broad definition and integrates the data flow and the managerial needs. As can be seen from the chart, there is a heavy emphasis placed on data accumulation, storage and retrieval, which is symptomatic of those authors closely aligned to computerization of MIS. An essential feature of the chart, not given particular prominence, is the step involving feedback and evaluation. It is considered that this deserves particular importance as the process of measurement is practically impossible without continuous returns of operating results and their proper evaluation as to how they integrate into the organizational scheme.

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[26]Ibid., pp. 96.

[27]Martino, R.L., Information Management: The Dynamics of MIS, (Wayne, Pa: Publications, Inc., 1968), pp. 43-44.

No discussion of managerial tools would be complete without the inclusion on an infamous "wheel." Included as Figure 7, Appendix A is the appropriate depiction of MIS as the hub of the entire company structure with the appropriate two way flow of data input and information output from the various organizational groupings.[28] The purpose of such attempts is to depict the information flow within an integrated system for providing management information. In theory, decisions from each department are directed to the MIS and reports are produced on their effect. The result being that there is a constant bilateral flow of information in addition to the constant flow of reports between departments and subgroups. This approach tries to justify Integrated Data Processing (IDP) or the Total Information Systems, which have been espoused by computer advocates in recent years. It is highly unlikely that such a Utopia can be achieved in the near future. Further, it is debatable whether such a system is desirous due to its complexity and potential costs. One has the impression that it is the MIS that drives the organization rather than the MIS being the servant of management. Perhaps, the interrelationship illustrated in Figure 8, Appendix A, would serve amply to place MIS in proper perspective.

Continuing with the idea of providing a chart in an attempt to clarify the nature of MIS, Dr. Heany offers the illustration shown as Figure 9, Appendix A.[29] Upon close observation it can be seen that the chart purveys the same thoughts as presented previously by Dr. Martino. The blocks may be labeled differently but the meanings are similar and the data/

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[28] Ibid., pp. 10-11.

[29] Heany, Donald F., Development of Information Systems (New York: Ronald Press Co., 1968), p. 11.

information flow lines are identical. It is such duplication of effort, with individual peculiarities, that tend to confuse managers attempting to grasp the essential ideas of MIS. Dr. Heany himself recognizes this fact as he states: "One can estimate the age of a profession by the vehemence and energy expended on the definition of its boundaries and its distinguishing marks. The younger the profession, the more vehement are the debates on these topics. According to this criterion, the information-system profession is quite young indeed. The general reader will lose little if he bypasses arguments about the differences between information-systems work and (1) systems and procedure work, (2) work simplification, (3) operations research, and (4) management science."[30] Perhaps the field of information systems can solidify into a more stable condition once the various authorities have aired their personal viewpoints and reached comparative agreements on essential definitions. Not to be deterred by such a goal, Dr. Heany submits his individual definition that closely parallels others previously presented: "A set of well-defined rules, practices and procedures by which men, equipment, or both are to operate on given input so as to generate information satisfying specifications derived from the needs of given individuals in a given business situation."[31] As can be noted from the foregoing definitions and attributes, each authority injects his own interpretation without substantively improving on a general basic definition. The following section will attempt to extract the important essentials and the basic thrust of MIS.

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[30]Ibid., p. 15.

[31]Ibid., p. 16.

C. ESSENTIALS OF MIS

The definitions of MIS, heretofore presented, range from the short one-liner to the comprehensive "shot gun" approach. No one definition can be considered the best for all purposes nor is it necessary to define all the items that the system is intended to accomplish. This will vary based on the intended objective of the system and the existing operating environment. However, it is important to point to those absolutely essential characteristics that must exist in order for an MIS to function effectively.

The MIS aids management to systematically make decisions based on processed data. This simplified thought is based on what MIS accomplishes and not on what the components are that comprise the system. The generic term "system" is in this particular case intended in the sense of the three phases of a system; namely, input, processing and output. It must be assumed that the important role of feedback is included as part of the input stage. The basic definition supplied above, although simple, conveys the gist of the more comprehensive definitions proposed earlier.

Generally, the consensus of the authorities screened, is that the information provided by a MIS must be timely (right person at the right time), relevant (maximum relevancy with minimum volume), and should meet the needs of management (pertinent information for planning and control). Further, it must provide for simplified measurement of actual against plan (exception reporting) and be designed to retain flexibility. This summation of the additional characteristics of MIS deals in the main with efficiency, the level of competency in performance, whereas the basic definition centers on a strictly effectiveness approach. The basic definition can be answered positively or negatively as to whether the MIS is adequate to accomplish a purpose, whereas the additional attributes can

be debated as to the degree, state or quality of being efficient. Thus the simplified definition, without the detailed descriptions or modifiers, permits a straight-forward approach to MIS. This conclusion is similar to that of Mr. Dunlevy, who states: "There are, of course, no universal set of factors that can be applied to determine the effectiveness of a management information system. What may be important to one organization may be relatively unimportant to another. The specific factors in evaluating a specific system depend upon the objectives of the organization, the strategies available for the achievements of these objectives and the rapidity with which these strategies will change."[32]

D. INTEGRATED SYSTEM AND COMPUTER ORIENTATION

The advantages of the computer to management have been proven in many areas. Proponents of the computer approach to management become overzealous at times and attempt to indoctrinate the receptive managerial audience with the concept that the computer, if not today then in the near future, will provide the panacea for virtually all ills that currently afflict the management community. This paper does not attempt to either downgrade or glorify the services that the computer has provided to industry nor to dwell on potential achievements predicted for the future. However, there is a definite correlation between MIS, the computer and the integrated system approach that should be addressed.

A growing number of individuals have attempted to extoll the virtues of a total MIS. There are cases where a few subsystems have been integrated. This has occurred where the organization was highly centralized,

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[32]Dunlevy, John H., Management Control Systems, A Short History from Fayol to Forester, MBA Thesis, George Washington University, Washington, D.C., p. 69, 26 April 1965.

had relatively few product lines and limited geographical concentration. While accepting the goal of a total MIS, which system designers may theoretically strive for, one must retain a sense of conservatism when the resources to be applied in attaining such a goal are taken into consideration.

A useful definition of an integrated system states, "An integrated information system is one in which all data will enter the system only once, in a universally accepted standard coding and simultaneously with its creation. The same data elements will be in no more different places in the system than vulnerability and relative economy of communications makes desirable."[33] No mention is made of computer application, but the generally accepted opinion of users indicates that integrated systems and computer application cannot be separated. Mr. Blumenthal, a strong advocate for integration and computers, traces the application of computers from the efficient replacements for regular clerical processes within business organizations through a second stage usage for communications switching, manufacturing control, production scheduling, order processing, passenger reservations, information retrieval and the like. He indicates that we have presently entered a third stage:

> "Today one enterprise after another has already integrated, is in the process of integrating, or plans to integrate heretofore disparate uses of computers into larger data collection, processing, functional and departmental boundaries of traditional organizations. The problems encountered in this more advanced employment of the computer are not solely or primarily technical and procedural, as they were before; rather they are to a very significant degree managerial and organizational."[34]

Many authorities and studies reveal the number of companies that have

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[33] Cicio, John David, Development of Computer Based Management Information System, MS CSM Thesis, Naval Postgraduate School, Monterey, Ca., p. 13, Dec. 1972.

[34] Blumenthal, Sherman C., Management Information Systems, (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1969) pp. 1-2.

integrated or are in the process of integration, but few admit to the realities of the degree of success achieved or the major problems encountered and unsolved.

Proponents of computers, systems integration or total information systems, tend to place the responsibility for slow progress in this area in the realm of management and continue to raise the specter of organizational resistance. Such a position is understandable in that eager systems designers are desirous of working on the newest, largest and most advanced developments. The pursuit for the all encompassing total management information system has not caught the desired attention of management as such a system appears to advocate a reimposition of the more unenlightened and authoritarian form of organization. It must be recognized that it is one thing to centralize routine rigorously prescribed, well-understood, relatively easily developed, and "managerial unsensitive" types of information processing operations like payroll or inventory reporting; but there is quite another set of implications to a concommitant centralization of management control of previously separate activities, especially where the development of "big" systems is involved.[35] One is quickly reminded of the recent turmoil in the computer community where the arrival of the "fourth generation" of computer growth was being heralded. More rational minds, perceiving managerial concern for such quantum jumps and obsolesence of older equipment, were quick to dampen such enthusiasm by attempting to illustrate that fourth generation had not really been achieved and only that third generation had been vastly improved. "Great leaps forward" have received adverse publicity in the recent past and may be subconciously retained in managerial minds when the comparison is made with the

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[35]Ibid., p. 5.

integration of smaller systems, sometimes referred to as "islands of mechanization," into a grandiose, total management information system. Mr. Enger concludes his support of MIS by challenging management with, "Fourth-generation hardware and software will further extend the capabilities of management information systems. The need for firm control of management information system operation can be expected to increase as these systems become more powerful, complex and sophisticated."[36] It would appear, for the present, that many managers have opted to exercise control by applying a "braking effect" on a totally integrated MIS.

Analysis of the planning approaches toward MIS reveals three avenues of thought. The radical entry requires the great leap forward, as previously discussed, where there is a complete separation with the past, both ideologically and organizationally. Advantages are that such a procedure will not involve a continuation of the basic processing disciplines currently installed and will allow fresh, incisive analysis relating to the real needs of the organization.

A modification of the above approach calls for a complete system design for the total system to be followed by the systematic implementation of segments consistent with the overall plan. The third approach, or "building block," would require design and implementation of logical segments of the total system. This approach has been utilized in the most successful applications.[37]

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[36] Enger, Norman L., Putting MIS to Work, (American Management Assoc., Inc., 1969), p. 224.

[37] Kelly, Joseph F., Computerized Management Information Systems, (London: The Macmillan Co., 1970), p. 63.

The design, implementation and attainment of the efficient and smooth operation of a total management information system has been projected to be from five to eight years.[38] Allied with such a large time gap are the requirements for detailed procedures and large capital investment over an extended period of time. Top management has displayed an aversion to being committed for such a lengthy time period when it appreciates the fact that most computer applications are based on a five year payback period. Mr. O'Brien states that "Large and complex systems designs are less desirable than modular phased installations. Further, the more complex are not only slower to install, but they tend to be more expensive - and are more difficult to utilize for the promotion of good staff relationships."[39]

It would appear that the soundest approach to the full integration of MIS lies between the second and third approach. An overall plan for integration is not undesirable as a planning function for the firm. Blind adherance to an established plan for integration may be detrimental to the firm. Change and environmental conditions may dictate that full integration may not be the ultimate objective. The plan for integration may have to be abandoned. Thus, a general plan employing a modular implementation of subsystems may provide the soundest approach during a period of rapid technological change. Information systems are capital investments and should have cost implications as any other project. Alternate approaches must be developed and evaluated seeking the ones with the highest payback.[40]

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[38] Kraus, Leonard I., Computer Based Management Information Systems, (American Management Assoc., Inc., 1970), p. 32.

[39] O'Brien, James J., Management Information Systems, (New York: Van Nostrand Co., 1970), p. 20.

[40] Benjamin, Robert I., Control of the Information System Development Cycle, (New York: Wiley & Sons, Inc., 1971), p. 15.

E. MANAGEMENT NEED FOR MIS

Basic economics supply the fact that it is one thing to have a product to sell, but it is mandatory that there be a willing buyer for the product. Does management really need a MIS? In many cases, the small firm can survive and thrive without MIS. In fact, management will only get involved in information systems to the extent that it is in their self-interest to do so, and because in some sense they feel rewarded by the use of such systems.[41] However, at some point, many organizations should employ MIS. The factors that usually dictate employment of MIS revolve around the growth of a business, an increasing rate of change in the environment and the presence of greater risks than previously encountered. Lt. Col. Mosier has performed studies of DOD executives (0-5, 0-6, GS-14 and GS-15) in designing a computer-based information systems course at the Industrial college of the Armed Forces and found that "...many executives do not have sufficient knowledge of information systems technology to fulfill their responsibilities for their computer-based information systems. Two highly interrelated factors contributed to this problem: the increasing complexity of the organizational environment, and the information systems technology explosion."[42] The education of executives as to what MIS really comprises should assist management in determining whether the organization can put the expensive MIS in a productive capacity.

There are many cases in industry where the educated executive openly admits to failure of the MIS. Hershman reports "Clearly, MIS so far has

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[41] Kriebel, Charles H., Richard Van Horn and Timothy Heames, Management Information Systems: Progress and Perspectives, (Pittsburgh, Pa.: Carnegie Press, 1971), p. 57.

[42] Mosier, Andrew P., A Study: What Executives Need to Know About Computer-Based Information Systems to Insure Effective Information System Development and Use (Wash., D.C.: Industrial College of the Armed Forces, 1971), p. 46.

been plagued by confusion and missteps. This has naturally led to disenchantment on the part of management and a very real fear of throwing good money after bad."[43] The conclusion is that MIS can work but that there are still significant problems that must be solved.

The following unfilled needs are fairly typical of most large organizations and can be corrected by an advanced and efficiently operating MIS.

1. Complexities in the information flow cause major communication problems and inhibit responsiveness and growth.
2. Duplication of effort.
3. Variations in field processing.
4. Inaccessability of data.
5. Time lapse where information made available is no longer of value.
6. Inaccurate source data.
7. Limited information support.[44]

Only the naive manager could expect the above difficulties to be corrected instantaneously. These problems require correction and must be established as goals that an MIS can aspire to.

There can be no doubt that the rapid pace on technology has produced an information explosion. The computer has created this condition and it should be the computer harnessed by MIS that should provide the solution. Managers have been overcome by the bulk of information available and seek a means of relieving the pressure. Krauss presents the key needs that management must fill in order to resolve the crisis as:

1. Render faster decisions.

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[43] Hershman, Arlene, A Mess in MIS, Dun's Review, January 1968, p. 87.

[44] Kelly, Joseph F., Computerized Management Information Systems, (London: The Macmillan Co., 1970), p. 61.

2. Accomplish more in available time.

3. Make more thorough analysis.[45]

As MIS technology improves, there are good reasons to believe that these management needs will be satisfied. MIS proponents are quick to assert that these are MIS objectives that must be met eventually if management and MIS are to become a compatible and effective team.

F. WEAKNESSES OF MIS

A large number of organizations have attempted MIS in conjunction with their computer installation and met with failure or a poor MIS. The reasons vary from company to company but several common weaknesses emerge. A detailed listing of the reasons would be extensive. The major factors are too-rapid installation, raw data difficulties, poor information outputs, sluggish management support and the low caliber of systems operators.[46] Additional blame is usually placed on outside consultants, design around the installed computer and a general underestimating of the complexity in designing and implementing stages of the system.[47] The general consensus of authorities is that these pitfalls can be avoided by a thorough analysis of the needs of the organization and refined planning for the implementation of the MIS on a systematic basis.

Mr. Ackoff finds fault with systems designers, who mistakenly assume they know what MIS must provide management. First, he stresses the fact that managers suffer from an overabundance of irrelevant information rather

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[45] Krauss, Leonard I., Computer-Based Management Information Systems, (American Management Association, Inc., 1970), p. 8.

[46] Ibid., p. 25.

[47] Gale, John R., Why Management Information Systems Fail, Financial Executive, August 1968, p. 45.

than a lack of relevant information. Further, managers do not know what information they will need nor will they make correct decisions even if they are given the information that they need. The manager may display poorer performance if additional channels of communication are opened. Lastly, the manager must understand how an information system works in order to use it properly.[48] The competent designer in conjunction with managers can avoid many of the hazards of MIS implementation.

There are many reasons given for MIS success and failure. It becomes apparent that two of management's traditional functions tend to dominate in MIS implementation. These are planning and control. The MIS is intended to assist management in the overall planning and control of the firm. Oddly enough, it is the absence of proper, prior planning and poor methods of MIS control that lead management into difficulties with MIS. The organization that is blessed with adequate planning and satisfactory control talents in the managerial field should find the MIS to be an able contributor in improving these skills.

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[48] Ackoff, Russell L., Management Misinformation Systems, Management Science, Vol. 14, No. 4, December 1967, pp. B147-B153.

IV. THE ROLE OF MANAGEMENT

A. MANAGEMENT BASICS

In order to merit attention from managers, a Management Information System (MIS) must assist management in executing the basic functions of managing and increase the probability of success in decision making. It is improbable that decision making will be simplified, as it is axiomatic that the greater the information that is brought to bear on a problem the more difficult it becomes to render a decision. The decision tree of decision theory illustrates such a concept. When a decision is made close to the "trunk" of the decision tree it is usually a case of a yes or no decision, or a selection from a limited number of alternatives. As one passes farther out on the limb of the decision tree, reflecting the accumulation of additional information, each decision becomes increasingly more difficult. With limited information, decisions are less complex but result in lower success ratios. More important, is that even though a success may be recorded with limited information, there is the potential that additional information would have uncovered a new alternative that may have offered a higher degree of success (larger profits). Management must realize, contrary to past publicity extolling the virtues of easier decision making resulting from MIS and computer proponents, that decision making will be more difficult; but, hopefully, more productive.

With the passing of each decade and the advent of a new generation of writers on management, there are uncovered new schools of management that attempt to develop an accurate and useful theory of management. Such a profusion of books and articles must eventually assist in developing the managerial art if one can avoid becoming totally confused by literature.

Koontz attempts to classify the various schools of management and restore some order to current thinking.[49] The Management Process School (traditional) perceives management as a process of getting things done by people who operate in organized groups. This concept was initiated by Henri Fayol and later developed by Frederick W. Taylor. The Empirical School, identifies management as a study of experience, sometimes with the intent to draw generalizations but often as a means of transferring this experience to practitioners and students. A more recent approach, enlightened by current philosophy about the individual, is the Human Behavior School, which is based on the central thesis that, since management gets things done with and through people, the study of management must be centered on interpersonal relations. The Social System School is closely related to the preceeding and looks upon management as a social system, that is, as a system of cultural interrelationships as developed by Chester Barnard.

Of more recent vintage and reflecting a close companionship with MIS and the computer are the Decision Theory School and the Mathematical School. The growing Decision Theory School concentrates on rational approaches to decision making; the selection of a course of action or of an idea from various possible alternatives. The Mathematical School views management as a system of mathematical models and processes. The management scientists, composed of operations researchers and operations analysts, believe that if management, or organization, or planning or decision making is a logical process, it can be expressed in terms of mathematical symbols and relationships.

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[49] Koontz, Harold, Toward a Unified Theory of Management, (New York: McGraw-Hill Co., 1964), pp. 3-9.

It is interesting to note the close parallel development of computer based MIS and these last two schools that rely heavily on the computer. The initial major concepts of the Decision Theory School were set forth by Luce and Raffia in 1957 with "Games and Decisions" and by Miller and Starr in 1960 with "Executive Decisions and Operations Research." The Mathematical School has been developed by McCloskey and Trefethen in 1954 with "Operations Research for Management" and by Churchman, Ackoff and Arnoff in 1957 with "Introduction to Operations Research." A case could be made that the Mathematical School actually developed with Taylor in the early 1900's, in that his work draws heavily on mathematical principles. However, one must separate his work from the Mathematical School in that the intensity of model and process applications is not as persistent with Taylor as with the operations community. Thus, it can be concluded that the major works of these two schools appeared during the mid and late fifties. This birth of management schools can be compared against the growth in computers. In 1953 installations numbered 20; by 1957, there were 200; by 1961, there were 2,000;[50] by 1970, there were 90,000; and by 1975 the number is expected to approach 200,000.[51] During the fifties, computer installations grew by a factor of 100 and two new schools of management evolved. With the continued growth of computers, one wonders if new management schools will continue to emerge by some corresponding ratio. Computers, being the result of advancing technology, appear to have spawned the newer management schools. One must consider the difficult questions of whether these new management theories are valid in themselves

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[50]Martino, R.L., Information Management: The Dynamics of MIS, MDI Publications, 1968, p. 20.

[51]Sanders, Donald H., Computers in Business: An Introduction, 2d. ed., McGraw-Hill, 1970, p. 53.

or if they are an accommodation to the computer, which has gained an increasing foothold within organizations and in the daily lives of managers.

Donnelly, Gibson and Ivancevich condense management theory into only three schools of thought.[52] The Classical School is based on the literature appearing during the pre-World War II period from the writings of Henri Fayol, James Mooney, Lyndall Urwick and Chester Barnard. These writers, who were pragmatic practitioners, were concerned with questions of efficiency, or the maximization of output to input ratios. The basic orientation of these writers was as "scientific managers" with the application of scientific methods of inquiry to the problems of work and work management. They centered on the process of coordinating group effort toward group goals.

The Behavioral School emanated during the 1940's and early 1950's. Based on the classic Hawthorne Studies of the 1920's this school relied on the concepts of psychology, sociology and anthropology and centered on the organizing and controlling functions of managing. The school has two branches, one pertaining to human relations and the other to the behavioral science approach. As a result, the former focuses on human behavior, managerial and nonmanagerial, in the context of work organizations, and the latter, the method of inquiry is the scientific method, with emphasis on the discovery of causal relationships.

The third school, Management Science, is a sophistication in the use of mathematics and statistics in the construction of models to aid in resolving the problems of planning and controlling. The idea of applying

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[52]Donnelly, James H., Gibson, James L., and Ivancevich, John M., Fundamentals of Management, Business Publications, 1971, pp. 11-14.

scientific methodology to large scale management problems can be traced back to the 18th and 19th centuries when Eli Whitney used a similar approach in the development of the cotton gin. During World War II and the following years saw the emergence of the management scientist (not the same as the scientific manager of Classical Theory) and during the sixties up to the present time numerous writers have erupted to further develop this school of management thought. The works of Ackoff, Arnoff, Miller, Starr, Morris, Schoderbek, Thierauf, Grosse and Wagner are representative of this school in recent years (1967-1970). It is difficult to place clear boundaries around the field of management science, but most management science applications possess the following characteristics:

1. A primary focus on decision making.
2. An appraisal resting on economic effectiveness criteria.
3. Reliance on a formal mathematical model.
4. Dependence on an electronic computer.[53]

A review of the three schools discloses that the Management Science School is closely integrated with the computer and MIS. The Classical School is related essentially with the computer and MIS in the areas of planning and controlling, while it appears that the Behavioral School is related minimally with the computer or MIS. It is no wonder that the Behaviorists are constantly critical of the depersonalization caused by the computer. Conversely, heavy emphasis has recently been placed on development and refinement of a Personnel MIS, which would be of considerable value to this group.

From the foregoing, it can be deduced that MIS and its management role are very closely aligned in the Management Science School. There is no

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[53]Wagner, Harvey M., Principles of Management Science, Prentice-Hall, 1970, p. 5.

apparent need to dramatize the value of the MIS and the computer to those managers who operate under this theory. Similarly, those managers categorized as being in the Behavioral School, do not hold MIS and the computer in high regard, and it is doubtful whether these individuals will ever appreciate the potential uses of MIS and the computer for other than payroll, records and inventory functions. Thus, it is with the managers falling within the Classical School that the merits of MIS must be explored. In order to prove the value of MIS to such individuals, it is necessary to analyze how these managers operate and to define where MIS can be of value.

B. SYSTEMS APPROACH

Before proceeding with an analysis of those managerial functions best supported by MIS, a brief review of the systems concept of management is warranted. Many authors prefer to define management theory on the basis of the particular approach envisioned, such as process, behavioral, quantitative and systems concepts. It is clearly evident that the first three approaches closely resemble those management theories previously offered. The systems approach, which should receive considerable attention in the 1970's and 1980's, attempts to envelop management as a total system of managerial subsystems. It has been proposed that a systems approach would cover the subsystems emanating from each of the other approaches previously mentioned. In general terms, systems analysis is the selection of elements, relationships and procedures to achieve a specific purpose. Professor Young has extended systems analysis to management by:

> "A management system can be defined as that subsystem of the organization whose components consist of a subset of individuals (man to man) whose duties are to receive certain organizational problems (inputs) and thereupon to execute a set of activities (process) which will produce organizational solutions (output) for either increasing the value of

return of the total organizational activity (satisficing) or for optimizing some function of the total organizational inputs and outputs."[54]

From this it can be seen that systems are deliberate, rational human inventions to achieve certain objectives. It is the manager who converts the conglomerate resources of funds, equipment and facilities, and humans into a productive enterprise. Johnson, Kast and Rosenzweig indicate that management is the process whereby these unrelated resources are integrated into a total system for objective accomplishment. They feel that the structuring of a business according to the systems concept does not eliminate the need for the basic functions of management. However, there is a definite change of emphasis, for the functions are performed in conjunction with operation of the system and not as separate entities.[55] Therefore, the systems concept does not deny that there are essential functions of management but simply unites these functions into a total system for the organization.

The basic functions of management, proposed by Urwick as a minimum, have been enumerated as planning, organizing and control. Depending on the definitions applied to these functions other authorities have further identified the additional functions of communicating, directing, staffing, execution and coordination. Without analyzing each individual impression of managerial functions, it will suffice to concentrate on planning and control as the two most important areas wherein managers and MIS are indispensible partners.

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[54]Young, Stanley, Management: A Systems Analysis, Scott, Foresman and Company, 1966, p. 15.

[55]Johnson, Richard A., Kast, Fremont E. and Rosenzweig, James E., Systems Concepts, Management Science, Vol. 10, No. 5, January 1964, pp. 9-12.

C. PLANNING

The planning function generally emcompasses all the managerial activities which lead to the clear definition of future goals and the determination of appropriate means to achieve these goals. Planning is the basic and primary activity of managers. The basic elements of planning center on goal setting, forecasting, policy making and budgeting.

The assumption has often been made that planning is the sole responsibility of the top or upper levels of management. In theory this may be true but in practice it is often not the case. The elements of goal setting, forecasting, policy making and budgeting most certainly capture the attention of top management, but any practitioner can attest to the fact that middle management is deeply involved in goal setting by virtue of such practices as management by objectives and formulation and reviews of budgets. It may be generalized that top management is more intimately concerned with strategic planning management while middle management tends to focus on tactical planning. Mr. Symonds states:

> "Regardless of the formal structure or apparent assignment of the management functions, however, two distinctly different types of activity actually take place in any typical business organization, and can best be described in terms normally reserved for the military. These are the two basic functions of strategic management and tactical management. The purposes, aims, and objectives of each are different, and each has its own separate needs and demands for management information."[56]

An important aspect of the planning function of management is that it involves a man and machine configuration. Little credence is given to the proposition that the computer and MIS can displace the human role in the planning process. Rather, most rational authorities agree that the machine takes over the routine chores of data acquisition, reduction and

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[56]Symonds, Curtis W., A Design for Business Intelligence, American Management Association, Inc., 1971, p. 8.

processing, by pre-testing proposed experiments and problem solutions, and by performing tasks that are essentially administrative rather than technical in nature. This has freed the manager to concentrate on the analytical and intellectual tasks that best utilize his talents.[57] The manager is thus able to maximize his ability to determine and adjust organizational objectives, discern those critical problem areas, distinguish important factors and relationships and ignore superficial variables and is allowed to insert his impressions from past experiences in conjunction with his inherent intuitive resource. The computer assists by handling masses of data with speed and accuracy. In this fashion, man and machine are integrated in pursuit of the ultimate in planning capabilities.

Mr. James Woodruff writing in the Navy Management Review further emphasizes the partner relation between management and the computer in carrying out the managerial functions and the decision-making process.[58] A fault of management is that managers continue to make small decisions which the machine has been told to make and has not educated himself into concentrating on the larger decisions which the machine cannot make. The planning function is performed in an environment where the number of variables put into the decision-making process is extremely high. Many of these variables are unquantifiable but managers have thrust the computer into this environment. The result has been a management psychology which thinks the machine has a mind of its own and because of this power, there has been an attitude that the computer can solve all management problems. He finalizes his views on the computer role as "It cannot replace the

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[57] Beged-Dov, Aharon G., An Overview of Management Science and Information Systems, Management Science, Vol. 13, No. 12, Aug. 1967, p. B-822.

[58] Woodruff, James G., Who is the Majority Making Management Decisions? Navy Management Review, September 1969, p. 7.

top-management function. At best, it can replace only a few of the middle and lower-level management functions."[59]

Management information systems derive their characteristics from managerial needs. On this basis, computers justify their existence and not the other way around. Zannetos states, "The aim is to relieve the manager of a lot of his present repetitive control and decision-making activities, allow him...to devote more time to planning, and provide him with information for guiding his actions and determining the efficiency of his planning efforts."[60] In order to assist the manager in these efforts, the MIS should contribute to the following planning activities:

1. Establishing overall organizational objectives.

2. Developing the theoretical (non-operational) plans which are considered necessary to carry out the overall objectives.

3. Translating the theoretical objectives and plans to a whole chain of operational objectives, subobjectives, plans and subplans.

4. Budgeting plans and operations.

5. Assigning plans to operational units.

6. Designing the information and control system which will compare the results from operations against the operating plans, the latter against the theoretical plans and finally theoretical plans against the overall objectives.[61]

The foregoing is illustrative of what the intelligent MIS can provide

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[59]Ibid., p. 11.

[60]Zannetos, Zenon S., Managerial Information Systems for Planning and Control, Working Paper 210-66, Massachusetts Institute of Technology, August 1966, p. 2.

[61]Ibid., pp. 3-6.

management in executing the planning function. By no means will a MIS be devised in the near future that will release management from personal performance of these activities. The objective is to have the MIS provide management with information that upgrades the planning process. Management cannot allow the MIS or the computer to have free license in the performance of such activities, but responsible managers must participate in the design, control and analysis of MIS to ensure that planning benefits are commensurate with the costs to implement and operate such systems.

D. CONTROLLING

Authors John Dearden and Robert Anthony essentially agree that the management activity of control can be categorized in the customary fashion as either management control or operational control. Dearden defines the control function as:

> "Management control, which consists of (a) dividing the strategic plans into logical subdivisions; (b) providing the funds to carry out the subdivisions of the plan; (c) assigning the responsibility for carrying out each of the subdivisions of the plan to some individual; and (d) following up to see that the assignment is being satisfactorily carried out.
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> Operational control, which consists of (a) determining the specific men, equipment, material and information necessary to accomplish the subdivision of the plan; (b) assigning these resources so that the plan can be carried out in the most efficient manner; and (c) comparing actual results with plans and taking corrective action where appropriate."[62]

Dearden stresses that information systems are applicable to operational control but are not suited for management control. The basis for this contention being in the difference in the automation of decision-making rules. Decision rules can be programmed into operational control systems because of their repetitive and routine nature while management control

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[62] Dearden, John F., Can Management Information be Automated? Harvard Business Review, March-April 1964, pp. 129-130.

decisions are not routine. Further, management control decisions are few in number and are made after a long period of deliberation thus not utilizing the foremost capabilities of the computer which are speed, repetitiveness, and a large number of routine decisions in a short period of time.[63]

Dr. Anthony feels that strategic planning is carried out almost exclusively by top management. Those activities under management control comprise a mixture of both planning and control. The activities classified under operational are almost pure control function and are in the realm of lower management.[64] On the basis of these definitions, it appears that information systems are most useful to the lower levels of management for operational control functions, with a minimum of application for middle and top level management in the areas of sophisticated controls and strategic planning purposes.

At the other end of the spectrum is the contention that once information systems are refined into "intelligent" systems then the applications in the planning and control functions are almost limitless. Prof. Zannetos optimistically forecasts that in order that the information system perform effective control functions, it must:

1. Measure and determine deviations from desirable performance.
2. Coordinate the various activities.
3. Encourage learning by making available specialized information.
4. Motivate those who determine the allocation of resources to do so efficiently.

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[63] Ibid., p. 132.

[64] Anthony, Robert N., Planning and Control Systems, Harvard University, 1965, pp. 15-21.

5. Provide premises for remedial action.

6. Encourage the use of substabilities (temporary, artificial or assumed stability) and standardization as a means to innovation rather than as an end in themselves.

7. Aid management in replanning at whatever level in the hierarchy is necessary.[65]

It can be gleaned from the above that some authorities consider the information system able to attain awesome stature. Point 5 in the above goes so far as to imply that not only does the information system provide the signals indicating the existence of problems but also whatever information is necessary for the decisions which should follow. Zannetos further predicts that:

> "As our capability develops to exploit the potentials of man-machine interaction systems, pattern recognition, and in general artificial intelligence, managerial planning and control will more and more become a science, utilizing fully the innate capacity of human beings. These systems we feel will serve as an extension to the human brain power, enabling us to do things we have not dreamed before, but for sure these systems will not subjugate us."[66]

The sophistication required to upgrade present information systems represents a monumental task, provided such a level is even attainable.

John Dearden views MIS as supporting the planning, controlling and operating function of an organization by furnishing uniform information in the proper time-frame to assist the decision-maker. Although computers and computer-related systems activities have been growing very rapidly, along with the significant costs, the quality of the information available to management appears unimproved. Much of the fault lies in the fact that management has been oversold on information systems and has been led to

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[65] Zannetos, Managerial Information Systems for Planning and Control, (Paper 210-66, Massachusetts Inst. of Technology, Aug. 1966), pp. 6-8.

[66] Ibid., p. 9.

expect much more than it has received. Information systems have not deteriorated but expectations have been over-inflated. Management will continue to operate with insufficient information. As the control decision increases in importance, the greater the uncertainty. Decentralized companies have suffered from control problems due to increases in size, complexity, and geographical dispersion. Unfortunately, new information technology has been of little help in this area, simply because the problems of controlling decentralized divisions do not lend themselves to computerized or mathematical solutions.[67]

The value of information systems to managers varies in accordance with the source. Opinions differ as to the relative value to top, middle or lower management and as to the degree of application in the managerial functions of planning and control. It is not necessary to set an indicator at an exact level of accomplishment but it is mandatory that managers understand that organizations have grown from merely Electronic Data Processing (EDP) to Management Information Systems (MIS), from hardware to a management system and from data processing to an information system. Although these changes have come about, management functions have not changed and will not change in the future. Management will continue to plan, organize, staff, direct, and control but must adapt itself to the changing environment with mounting complexities and maximize the use of MIS in order to effectively manage the organization.

A flow of information must be provided to the decision makers. Depending on the company, varying stages of sophistication have been achieved with additional room remaining for improvement. The upgrading of existing

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[67] Dearden, John S., MIS is a Mirage, Harvard Business Review, January-February 1972, pp. 90-97.

systems must result in applications that will provide improved information that will aid in better management decisions. With each advance, managers will be released to devote more time toward implementing company policies, strategies and supporting plans.

V. MIS FOR IMPROVED UTILITIES MANAGEMENT

A. NEED FOR IMPROVEMENT

In the past century the people of the world have consumed at least half as much energy as in the preceeding eighteen and one-half centuries. The rate of growth in the world demand per capita for the output of energy appears to have averaged about 2.2 percent per year, compounded, since 1860. In recent years the growth in the United States has been close to four percent.[68] By 1830 the United States had become the heaviest consumer of energy in the world. In 1860 the United States contributed 27 percent to the total world energy system and at present is close to 40 percent.[69] Faced with this increasing demand for energy, knowledgeable authorities for many years have been predicting an energy crisis.

The recent Middle-East oil embargo awakened the general public to the grim realities that stem from an energy shortage. "Low-cost" reserves of energy are rapidly dwindling. Rates of extraction of the non-renewable fossil fuels, such as coal, oil, and gas, have been spiralling. Even though the efficiency of use of energy sources has more than trebled due to advanced technology it is doubtful whether technology will be able to maintain such a pace in the future. The environmental impact has had a further adverse affect on these "low-cost" energy sources. With the demand for energy increasing and available reserves of "low-cost" fuels decreasing it becomes evident that steps must be taken to maintain

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[68] Putman, Palmer C., Energy in the Future, D. Van Nastrand Co., Inc., 1953, p. 97.

[69] Ibid., p. 221.

availability of "low-cost" energy in order to support the economy which derives its liveliness from this source.

Some possible steps have been proposed. Use of "low-cost" energy (economically retrievable under present technology) is limited and can only make minor contributions to the energy needs of the future. Fuel wood, farm wastes, water power, solar heat collectors, wind power, temperature differences in tropical waters, tidal power, heat pumps are some sources of continuously available energy. But, in aggregate, it has been estimated that they could hardly carry over 15 percent of the total future load under "low-cost" concepts.[70]

Solar energy and nuclear fuels have been proposed to meet future requirements. Solar energy, at present, appears to be prohibitively expensive. Nuclear fuels are in abundant supply and hold considerable promise as a "low-cost" energy source. Current social thought has not allowed this field to develop as rapidly as it might, but recent events may have paved the way for substantial development in the future. Development of nuclear power, or other improved "low-cost" energy sources will require time, in addition to huge expenditures in capital and manpower resources.

The only immediate relief would be to ease the energy demand and to more efficiently produce and deliver energy to the consumer. Management must get involved in this effort by attempting to reduce requirements and operate efficiently in the energy area. Utilities and energy are closely related. The efficient management of utilities systems will result in a direct contribution to living with the current and forseeable future of

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[70]Ibid., p. 252.

energy crisis. To manage utilities wisely, managers require a modern, efficient management information system.

The President and the Department of Defense have required that energy consumption be reduced during FY 74. The Navy goal is presently a reduction of overall energy consumption during the reporting period of 15 percent relative to the comparable period during the base period of FY 73.[71] A 15 percent reduction cannot be achieved by edict alone, but can only be accomplished by management planning and control that is supported by adequate management information systems.

B. CURRENT NAVY DEMANDS

The UCAR information system as discussed in a previous section has not met the managerial needs in the current environment. A present example of this failure has been the implementation by DOD of the Defense Energy Information System (DEIS) for Shore Utilities Consumption. One purpose of DEIS is to monitor energy conservation performance relative to established goals or limits. Voluminous monthly reports are required from each Naval Activity to reveal the level of attainment toward the 15 percent utilities consumption reduction goal and explanations in those instances where goal achievement has not been attained. A new computer program has been established at the DOD level to collect, process and evaluate the submitted data. Although the DEIS program is in response to a national effort, the system appears duplicative, an undesirable centralization of previously decentralized management and a reflection of the shortcomings of the presently functioning system of utilities management.

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[71]Commander Naval Facilities Engineering Command Letter 1021 B/RJK to Distribution, Subject: Defense Energy Information System (DEIS-2) Shore Utilities Consumption, 4 April 1974.

The UCAR system as presently established does not appear to be providing all levels of management with the information that it needs, which has been previously cited as a prime characteristic of an effective MIS.

The Naval Facilities Engineering Command (NAVFAC) has recognized the need for proper management planning and control for utilities management with the internal need for data accumulation and responsive, on-demand reporting to higher echelons. Although much of the data base resulting from the UCAR has been computerized and is available, there often results a monumental effort to extract information in the required format. While data handling and reporting comprise only a part of an MIS, it is mandatory that such procedures be uniformly established within the Navy and eventually DOD in order to facilitate information in conjunction with the daily utilities management effort. As a result, NAVFAC has established within its Command Management Plan, a goal of performing the first major review of public works management systems in approximately twenty years.[72] The concept of this study effort is to make simpler and more efficient the existing public works management systems. The end result of subsequent systems revisions/modifications should provide Public Works Departments with new operating and business philosophy, and new and improved management information to increase departmental output performance. This approach was advocated by Captain Malcom T. Mooney in his Master of Science in Management thesis at the Naval Postgraduate School. He found that certain functional areas required disproportionate amounts of the Public Works Officer's time and certain areas needed improved reporting

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[72]Naval Facilities Engineering Command, FY 1974-Command Management Plan (NAVFAC P-441), June 1973.

techniques.[73] His sampling of seventy Public Works Officers stationed world-wide found that the UCAR received regular usage by only slightly less than one-half of the PWO's and their staffs. Criticism of the UCAR was intense and adversely commented on by one-third of the PWO's and their staffs. Criticism was extended toward the complexity of information and excessive detail which made it difficult to use in a broad management context.

One of the difficulties facing the establishment of a worthwhile utilities MIS has stemmed from the alignment of financial and command responsibility within the Navy. Certain peculiarities of organization and programming within the Navy have contributed to the present difficulties. As an example, in 1962 the overall responsibility for facilities management (public works) functions of the Navy, together with administrative control of funds available for financing these functions, regardless of any other command's responsibility for its assigned facilities, was assigned to the Bureau of Yards and Docks (now NAVFAC). With the shift in FY 1968 to the concept of command responsibility for resources, public works funds were again merged with other operation and maintenance funds available to the respective command echelons.[74] The obvious advantage of this realignment has been to assign responsibility and total resources available to the single manager. However, the drawback has been that the single manager does not have the familiarity or close interest to actively pursue utilities management and the MIS that supports this effort. As a result, management systems have been viewed with skepticism and considered

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[73] Mooney, Malcom T., A Survey of Public Works Officers' Time Utilization and Reports Use, MS Management Thesis, U.S. Naval Postgraduate School, Monterey, Calif., 1965, p. 45.

[74] Bureau of Naval Personnel, Financial Management in the Navy, U. S. Government Printing Office, 1969, p. 64.

to be merely another contribution to the burdensome reporting requirements afflicting the Navy. The general reaction heretofore, as observed by the author, has been to eliminate or disregard rather than to simplify or improve existing systems. A growing concern has been expressed in the reduced level of real property maintenance and utilities operation due to funding and outdated procedures. The Department of the Navy therefore has taken steps to improve this situation. The major step was to assign to the Deputy Chief of Naval Operations (Logistics) the centralized direction, control and distribution of resources for facilities management functions through appropriate chains of command. As a principal advisor, NAVFAC and its field activities provide authoritative advice and assistance to shore commands at all levels. These specific designations should permit the application of more uniform procedures and renewed command interest in facilities management throughout the shore establishment.

C. TOP MANAGEMENT GUIDANCE

The Department of Defense (DOD) has recognized that with the environment of increased costs and austere budgets that it is imperative that newly developed management technology be adapted and implemented in facilities management (includes utilities) matters. While there is still great interest in cost reduction, formal DOD programs appear to have fallen into a routine reporting nature with a subsequent loss of initiative at the field level. On 18 September 1973, OSD announced that a series of studies were underway to bring about more efficiency and to reduce costs. Included in the studies are proposals to streamline management.[75] Cost control has evolved through the years into the various reporting systems

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[75]DOD Real Property Maintenance Council, Fourth DOD Real Property Maintenance Conference, January 1974, p. 36.

presently in use by the Services. Each of the systems deal with and produce cost reports and projections. Review and analysis of each system employed should retain the good, discard the bad or useless, and make necessary improvements to arrive at a concrete and standard MIS for all services. Cost is only one aspect of management concern and the question must be asked, "What constitutes an effective MIS?" DOD is considering a fully automated system that includes not only cost but also scheduling and performance evaluation. As discussed earlier in this paper, this approach has been championed by the "visionaries" and is fraught with many unsolved problems. A conservative or incremental approach may be more suitable in terms of economy and management disruption.

There is considerable support at DOD levels for consolidation of the utilities management effort. The establishment of Joint Utilities Services Boards to provide joint cost effective organizations to solve mutual utilities procurement problems, ensure more effective utilities contract negotiations and to improve conservation programs deserve merit and further consideration. The far-reaching proposal of consolidating utility systems, and providing management and funds as an industrial fund activity, offers wide ranging benefits and some simplification where utilities are provided on a cross-service basis. The permeating thought remains; if innovative ideas are to be implemented there should be an effective MIS to facilitate study and development efforts along with providing the required management support when the program enters the operating phase.

The Department of the Army has also recognized the need for MIS. Extensive studies are being conducted in the Base Operations (includes utilities) Management area. Since 1967, the Army has been developing a standard, automated information system for the management of real property resources within the Continental United States. The system, called the

Integrated Facilities System (IFS), is being designed to support the planning, programming, budgeting, execution and review of facilities management responsibilities. Data requirements at OSD level are in a period of transition from the detailed current and budget year entries to summary level information. This conforms to the Army's desire to manage with summary level information at Department of Army level and maintain details at the installation.[76] Noting the time frame during which such studies have been conducted reflects on the complexity and scope under which MIS design and development assignments operate. MIS, the elusive management tool, is difficult to define and no less difficult to design or implement.

D. PROPOSED MIS DIRECTION

As developed in this paper, the utilization of MIS ranges from a one-man operation of a small business enterprise to the ultra-system of managing within the huge Department of Defense complex. Long time and crash studies, brought about by the energy crisis, are being pursued in order to develop the MIS that will be tailored to the modern manager. It becomes clear that MIS in some degree, is worthwhile and that utilities management in the Navy deserves a modern MIS that will be responsive. To meet the basic concept of MIS and the present, specific needs of the Navy, the following outlines an approach to the MIS dilemma.

In its present form, the UCAR is a collection of data with some useful attributes but does not meet the true criterion of an effective MIS. A complete MIS for utilities management must provide the manage with timely, relevent reports needed for mission accomplishment while meeting all the

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[76]Logistics Management Institute, Base Operations Management Study, LMI Task 73-13, September 1973, p. 137.

reporting requirements stipulated by higher authority. In total, it should provide information on the performance and condition of the utility system, indicate the effectiveness of utility service utilization and operational efficiency and allow the determination of the extent a particular utility service has been used by various customers.

The scope of the Utilities MIS is generally determined by three basic constraints; the reporting needs of higher management, the interface with other management systems, and the types of utilities to be managed.

DOD requires that the Navy highlight the effectiveness of its utilities management program by a summary report entitled the DOD Installations and Logistics Report (DD I&L (A) 715). This report can be easily generated from the data contained on the UCAR. Since the UCAR should be retained, with some simplifications, it requires only one extra step in order to produce the required DOD report. Further, although the need for reporting is challenged by some critics, the necessity of the report requirement is valid until modified or deleted, which would require considerable time and effort within the huge defense establishment.

In regard to interfacing with other existing or proposed management systems, it is not necessary that the utilities MIS become fully integrated under a total MIS for facilities management. To do so would only extend the time frame under which the utilities MIS can be implemented and increase the complexity of the system. Where necessary, data transmitted between systems can be handled on an exception or manual basis. To achieve this state it is necessary that the utilities MIS be capable of operating in a manual, machine-manual, or machine-only mode.

The extent of utility system coverage should be minimized to those systems that have significant costs associated with their operation. The attempt to trace costs, utilization and efficiencies of relatively minor

operations, such as pneumatic power, would result in unnecessary expenses that may not justify close observation. These utilities could be handled satisfactorily by rough estimating and allocation procedures. In most cases it would suffice to center management attention on the British Thermal Units (Btu's) of heat and on Kilowatt-hours (kwh) of electricity. At certain installations, the utilization of air-conditioning and water utilities are significant and future improvements to the utilities MIS should address these areas. For the present, the utilities MIS should confine itself to major utilities, such as electricity and heat, and be independent of other management systems and provide only those reports that are absolutely required.

A comprehensive Public Works Department Management Information System was proposed by NAVFAC in July 1971.[77] The purpose of the management system was to integrate public works functions into a total system. To date the proposal has not met with success and has diminished in importance. The Utilities Management system was intended to be integrated with other subsystems, such as maintenance, financial, and real property inventory. The utilities system consisted of three basic, integrated modules consisting of a data module, target module and an allocations module. The involution of the system contributed to the lack of field response for implementation.

The desirability of a target and allocation module is questionable. The target module was intended to provide information on the effectiveness of service utilization and operational efficiency, while the allocations module was to provide information of the extent that a particular utility

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[77]Naval Facilities Engineering Command, Public Works Department Management System (Draft), P-428, July 1971.

service has been used by various customers. A brief review of these modules will reveal that they hindered a total system adaptation and caused the data module, a potentially useful MIS, to be neglected.

The target module is designed to provide management with an effective means of evaluating actual utilities usage against a "standard" or "target." A target is an engineered determination of the quantity of utility service that should have been used during a particular period. By comparing actual against target should indicate when an activity has excessive or poor usage. The scope appears valid, but analysis of input requirements and output value does not support the need for the target module.

Input requirements are extensive and require considerable engineering effort for preparation. These include building physical data (area, volume, insulation, connected loads, etc.), calculation constants (usage, configuration correction, energy and demand usage), and calculation variables (degree days and activity operational factors). Accumulation of this data is expensive and requires engineering talent that is usually not readily available in the average Public Works Department. Further, much of the basic data is unrealiable and results in error listings after processing. These listing reports include (1) Target Generator Error Listing, (2) Cost Center Hours Error Listing and (3) Building Extract Error Listing. These listings of unsuccessful transactions must be thoroughly reviewed at a not insignificant expense and considerable consternation to the staff.

In reward for the input and corrective efforts the module would provide engineered estimates of doubtful value. The basic output report would provide by customer/cost center the estimated quantities of heat and electricity that should have been used during a period. The benefits of

management knowing in exact quantities of anticipated future usage and possible areas of excessive usage does not equate well on a cost/benefit scale. The quantities projected are only best-guess estimates based on unrefined data. Indications of excessive users is degraded by changing conditions, such as variations in degree days, vacillating usage requirements and changing missions. In essence, the unreliability of basic raw data, large investment of scarce engineering resources for input and update control, changing environmental factors and the dubious value of output negates the inclusion of a target module in an effective utilities MIS.

The allocations module is also of minimal assistance to utilities managers. It is designed to provide procedures that assure to all customers an equitable recovery of expenses incurred in providing utilities services, as the quantitative data produced would be the basis for distributing the utility expense to the customers. The objectives of the allocations model center around the need for standardized procedures, accurate and equitable distribution of expenses and utilization of a more economical, completely machine oriented allocation of expenses.

As with the target module, which provides input to the allocations modules, the inputs are heavy in comparison with output. Inputs are the building utility targets from the target module, building utilization by cost center, and meter readings. The basic output document is the Customer/Cost Center Allocations report that provides quantitative data by accounting entity that can be multiplied by an established activity rate and leads to customer billing.

The standardization of procedures is usually meritorious but at many activities it reduces flexibility. It also has the inherent disadvantage of forcing inputs to conform with a rigid procedure with the outcome being

that disruptive debates emerge resulting from the impersonality of the procedure and a lack of basic understanding of the method objective. Accuracy and equitability of expense distribution at most Naval Activities is not of paramount importance. Utility systems at Naval Activities are atypical from commercial enterprises in that the profit motive is absent. The profit incentive must be replaced by the manager's pride in economy. Thus, Naval customers do not expect unreasonable billings but are more interested in approximate but timely charges. Computer accuracy is totally dependent on input accuracy. Further, computer outputs at most activities, when viewed realistically, involve serious time delays. Most customers when given the option of (1) extremely accurate, standardized and equitable distribution by computer of utilities costs or (2) a reasonably accurate and fair expense distribution that is timely and subject to impartial negotiation of differences, would primarily select the latter option. The foundation for this premise rests on pragmatic experiences with standardized, accurate billing systems that are in present day operation.

It is currently within the realm of feasability to design the ultimate computerized utilities system. This would envision metering at points of production and consumption with automatic feed-in of readings to the computer. The computer would process the inputs in accordance with programs and send return signals back to the producing point adjusting controls to generate the desired level of output. At the same time, by virtue of target and allocation models, the computer would process meter inputs and produce billings to customers on a daily basis if desired. Because such a concept is possible is no reason that such an objective should be pursued. Similarly, the target and allocations modules are workable but economic analysis and the limited availability of resources does not favor

such a venture. Available resources could be more gainfully employed in upgrading the present inadequate metering systems that exist at most Naval installations. The target and allocations models should be reserved for a future date when conditions may be more appropriate and advances toward a total system can be justified. A cost/benefit study of the target and allocations models presents an opportunity for a thesis that would challenge or verify the general observations stated above.

The data module offers immediate promise as an achievable MIS that would serve present utilities management needs. The data module provides management information on the performances of an activity's major utility systems and the utilization effectiveness of major utilities services. Quantitative and cost data relating to these systems are manipulated and presented in such a manner that management can assess performance and determine specific areas where action should be taken to obtain acceptable performance. Outputs will also aid in the further refinement of existing standards, the establishment of additional performance indicators, if needed, and assist in the preparation of budgets and financial plans.

The data module, since it provides management with desired information, is best termed as a proposed Utilities Management Information System (UMIS) for reasons previously set forth regarding the distinction between data and information. The proposed UMIS should accomplish the following objectives:

1. Measurement of quantities and costs for utilities services.
2. Rapid and accurate methods of converting data into relevant information.
3. Simplified procedures for collecting utilities data.
4. Exception-type reporting.
5. Effectiveness reporting of utility management to higher authority.

6. Establishment of current and reasonably accurate utility rates.

7. Management indicators for comparison of actual against planned performance.

Inputs to the proposed UMIS have been minimized and consist of financial, quantitative and conversion data that are currently being accumulated in normal operations and no additional collection requirements are being imposed. If the computer is utilized, it is expected that data collection and manipulation requirements would be lessened.

Financial data inputs could be interfaced with an automated financial system if one presently exists. If not then such input could be manually entered. The financial data are the actual expenses associated with providing utilities service and are available in the Fiscal Office under standard Navy Accounting Systems. These expenses are for labor costs, fuel costs, material costs, contract costs and military labor costs.

The quantitative data inputs include the actual and estimated meter readings for each month that are currently prepared by the Utilities Division. Conversion data are the engineering factors that are programmed into the computer to convert meter readings into usable information. Meter conversion and system configuration factors, physical conversion factors are prepared jointly by the Utilities and Engineering Divisions. Figure 10 of Appendix A depicts the flow of data in the system.

The proposed UMIS functions are displayed in Figure 11 of Appendix A and produce three basic outputs. The UCAR, as previously discussed, provides detailed quantitative and cost data on all major utility systems common to an activity. The DOD Installations and Logistics Report is a higher authority requirement and is produced annually displaying summary utilities data along with other functional summaries.

The third and major output that is deemed most beneficial to utility managers at the activity level is the Management Indices Report. This report provides a quick and simple display of ratios of the various elements that must be examined to determine if utility systems are operating efficiently and economically. Quantitative ratios indicate plant efficiencies, effectiveness of utilization, and plant loadings for each utility system desired. Unit cost information is provided for utilities produced, purchased, and delivered and a comparison of the actual delivered unit cost to the established activity rate. In addition such ratios as production overhead and distribution overhead to direct labor and, if relevant, the actual ratio of public works maintenance to contract maintenance for both production and distribution are also available.

It has been common practice in the past to manually chart these indicators in order to detect trends. There is no objection to continuing such practices, but it is considered that the better management approach would be to program into the computer, for any of the above ratios, the known ranges of acceptable performance. Only those ratios not falling within such ranges would be identified in the output. Examples of this method are numerous but the following are typical and useful:

1. Fuel quantity to net plant production ratios that are above the specified range indicate equipment in need of repair, replacement or overhaul or that equipment is operated in an uneconomical manner. The occasion of the ratio falling below the specified range may result from exemplary performance by utilities personnel. In all cases of indicators falling outside specified ranges caution must be exhibited by ensuring that metering is not in need of calibration or adjustment or that incorrect data or factors are not employed in the calculations.

2. Unit cost delivered to established activity rate would establish whether the activity rate is recovering more or less than actual utility expenses. Indicators would direct attention to the assumed factors and procedures used in planning and operation.

3. Production overhead to direct labor would reflect exemplary performance or conversely that there is improper charging of expenses to overhead or perhaps a high overtime ratio.

4. Public Works maintenance to contract maintenance costs for production and distribution reflect comparative efficiencies of these maintenance procedures. Further studies would indicate increased contract maintenance if the indications are that this source is more competitive or that trained in-house personnel are not available.

The benefits of the proposed UMIS should allow an orientation toward management by exception and reduced clerical and engineering costs, while specifically providing the following:

1. The Management Indices Report that is on the exception basis and quickly shows the effectiveness of utilities operation.

2. Performs summations of costs and calculations of unit costs needed for the UCAR, which will continue to be useful to management at various levels.

3. A comprehensive data base is achieved. Automation of the data base allows rapid development of management indices, higher level summary reports and other utilities information as needed.

4. Flexibility for future development of data requirements for budget resource requirements, equipment/system replacement, and construction planning.

5. Annual generation of the DOD Installations and Logistics Summary Report.

6. Systematic accumulation of quantitative data (meter readings) that is rapidly, accurately and consistently processed for multiple needs.

VI. SUMMARY AND CONCLUSION

A. SUMMARY

The manager, being human, is conditioned by the environmental conditions surrounding his work operations. In order to succeed, the capable manager must be flexible and innovative. The alert present day utilities manager has observed that there have been two recent technological events that have occurred that impact on his sphere of operations. The first was the creation of a problem and the second, fortunately, offers the means for coping with the problem. The energy or utilities crisis is the current problem and an effective Management Information System (MIS) is the proffered solution.

The initial chapter outlines the enormous expense of utilities in the Department of Defense establishment. Because of the rising costs of utilities and the mounting scarcity of utility sources, concern has been voiced up through the Presidential level. In order to respond to the challenge, management must have the adequate assistance of an MIS, designed with attainable objectives.

Before embarking on inflated schemes that promise instant remedies, it is necessary to evaluate what has been done in the past and what presently exists that can be built upon or modified. The Utilities Cost Analysis Report (UCAR) has been in existence for over ten years in the Navy and has served as the primary management report in the utilities area.

The UCAR has functioned as a prolific and comprehensive gatherer of data. Unfortunately, the UCAR falls short of achieving MIS status. The analysis of the UCAR reveals an extremely complicated and tedious system

of collecting utilities data. It is recognized that the UCAR serves the role of meeting higher authority reporting requirements but usage by management is restricted by its complexity and lack of significant indicators of utilities operations. Conversion or improvement of the data contained in the UCAR is necessary before management will be willing to employ it, or its successor, as an efficient management tool that will result in the best possible dedication of available resources.

Chapter III reviews current thought on Management Information Systems in order to develop an understanding of what a MIS is potentially capable of providing. Even with the discounting of promises made by eager proponents of MIS, it is apparent that MIS can be extremely beneficial to managers if properly approached. The advantages associated with the union of the computer and MIS are quickly recognized even though MIS can function without the computer. The computer has become a tremendous ally of the manager but critics have cautioned that it may become the insurgent enemy of the future if not properly controlled. This view is in accord with that of Mr. John H. Dunlevy who concludes his management thesis by imploring that traditional management theory "...can further contribute by diverting attention away from the highly attractive technological achievements in data handling to the more important problems of management information needs and control responsibilities and toward an emphasis on 'better' information rather than 'more' information, 'better' control rather than 'more' control."[78]

The lack of a common definition for MIS should not detract from its desirability. Numerous authorities have supplied various definitions and

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[78]Dunlevy, John H., Management Control Systems, MBA Thesis, George Washington Univ., Wash., D.C., 26 April 1965, p. 101.

innumerable characteristics, but it becomes evident eventually that there is some common ground. Essentially, the MIS aids management to systematically make decisions based on processed data. The MIS will be accepted by managers only if it contributes to management informational needs.

MIS can be a very simple affair or an incredibly complex involvement. Total or integrated information systems with computer basing are alleged to be capable of filling all of managements information needs in one package. This may be true in theory, but results to date have not substantiated this position. This is corroborated by two separate proponents of computer based MIS in their thesis work. LT Cicio concludes his work by optimizing that "Eventually, when the necessary technological advances have occurred, the system designer will be able to develop a total computer based management information system."[79] Mr. David Ringberg, in a more rational conclusion, states:

> "It is concluded that many problems have indeed been encountered; and that many costly blunders have been perpetrated in the process of computer-based management information systems development . . . In any event, despite the problems and pitfalls, it is concluded that even the staunchest critics will agree that future survival in this information packed world requires efficient application of dynamic and responsive management information systems; and that, if systems are developed to meet needs on a sound, economical basis, they can be efficient cost saving, and indispensible tools of management."[80]

Regardless of the many voices extolling strengths and weaknesses of MIS, computers and integration, the prudent manager will arrive at his own conclusions based on his own needs and anticipated performance.

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[79]Cicio, John David, Development of a Computer Based Management Information System, MSCSM Thesis, Naval Postgraduate School, Monterey, Ca., December 1972, p. 66.

[80]Ringberg, David Allen, A Survey of the Advantages and Problems Associated with the Development of Integrated Management Information Systems MBA Thesis, George Washington University, Wash., D.C., May 1972, p. 80.

Managers have been misled in the past, and in many cases still are, by those who would have him believe that MIS and the computer will relieve him or his staff of their managerial responsibilities. Too often, the management task has been made more difficult by too much data. There is an over-abundance of nice-to-know data rather than a hard core of significant information. The MIS must effectively prune out that which is available for massage from that which is needed to manage.

Chapter IV reviews the basic functions of managers and stresses the functions of planning and control as the two areas where the manager can seek assistance from a MIS. Without downgrading the need to perform well in all managerial areas, it soon becomes clear that planning and control will always be a prime responsibility of managers and no system of managerial theory, computer potential or MIS promise will ever relieve the competent managers of these functions.

The functions of planning and control are subdivided into sub-functions, such as strategic or tactical planning and management or operational control. The degree of utilization of MIS in each of these sub-functional areas will vary depending on the organization, the manager, the tasks to be performed and the goals or objectives that are pursued. The MIS is capable of aiding in each area and may theoretically assist in all areas at the same time, but concentration on a totally integrated system is seldom worthy of the effort. When the individual manager perceives that a MIS can assist in a particular area, then it should be incumbent upon him to seek an effective or tailored MIS in the shortest time possible.

The all encompassing approach to utilities management in the Navy would be for a totally integrated Utilities Management Information System that is computerized and interfaced with other Public Works, Fiscal or Property Inventory systems. Chapter V discusses the basic components of

a UMIS that entails modules dedicated to data, targets and allocations. The need for improvement is based on dwindling sources of "low-cost" fuels and higher authority perception of this present and future problem.

Constrained by the reporting needs of higher management, the interface with other management systems and the particular utility systems to be evaluated, the various inputs and outputs of each module are analyzed. The efforts expended to generate the target and allocation modules, which provide information on utilization effectiveness, operational efficiency, and customer utilization, are determined to be excessive. The data module, with refinements, appears worthwhile for development as a proposed UMIS. The data module outputs consist of the Management Indices Report, (which fills a current void at the activity manager level) in addition to the continuing need for the UCAR (an important data collector) and the DOD Installations and Logistics Report (a higher authority requirement).

B. CONCLUSION

Authoritative predictions are united in the opinion that present energy sources are vanishing and costs for energy will rise as the supply-demand formula exerts itself in the future. Development of new energy sources will require immense manpower and capital resource consumption over an extended period of time. In the interim, there is an urgent necessity that managers use available methods of existing in this austere and demanding climate. A Utilities Management Information System (UMIS) offers a means whereby utilities managers can continue to operate to the satisfaction of corporate and public trust.

The thrust of MIS is to provide managers with timely and relevent information that will assist in execution of decision making responsibilities that will maximize the results of utilities operations. The MIS is

most applicable to the planning and control functions of utilities management and must expand away from present day data base orientation (UCAR) toward an output orientation that is user-dependent (proposed UMIS). Totally integrated systems should be recognized as being complex and heavily dependent on scarce, available resources and fascination with such models should be limited to the realm of theorists for the present. Computers, properly employed, contribute to the validity and usefulness of the MIS concept.

The UCAR is complex and is filled with excessive data that limits the extent to which it fills the utilities manager informational needs. The proposed UMIS, while retaining the UCAR as a necessary statistical data collection, provides a refinement in a simplified format by virtue of the Management Indices Report that allows attention to be devoted to significant indices that are timely indicators of current utilities operations and require a minimum of interpretive effort. The data of the UCAR should be accumulated in a comprehensive Navy-wide data base, while the indicators should be realistically applied to detect trouble spots and assist in analyzing proposed, remedial management actions. Indices also furnish a basis for comparative performance statistics between activities or claimants. Caution must be exercised in that the indicators themselves do not proliferate to an extent that their abundance overweighs their relevance and timeliness and eventually the usefulness to the first-line managers whom they are intended to support. The proposed UMIS continues to meet higher authority reporting requirements without generating additional requirements for scarce resources that result in extraneous outputs of questionable value.

The imperative is to act with minimal delay to give utilities managers a simple but effective implement to achieve a detente with the energy/

utilities exigency. Future studies and thesis work can investigate the merits of expanding the proposed UMIS to include all utilities, on a cost/benefit basis, or the integration of all facilities management subsystems into a single or total MIS. However, during the interim, the UMIS proposed in this thesis does not attempt integration with other management systems that would impede implementation or exact additional, significant resource expenditures; but, it does build upon an existing base to provide managers with a simple, inexpensive, relevant information apparatus. The present UMIS, in capsule, must aid in current problem solving rather than fostering additional problems for the already beleaguered utilities manager of today and those that manage in the near future.

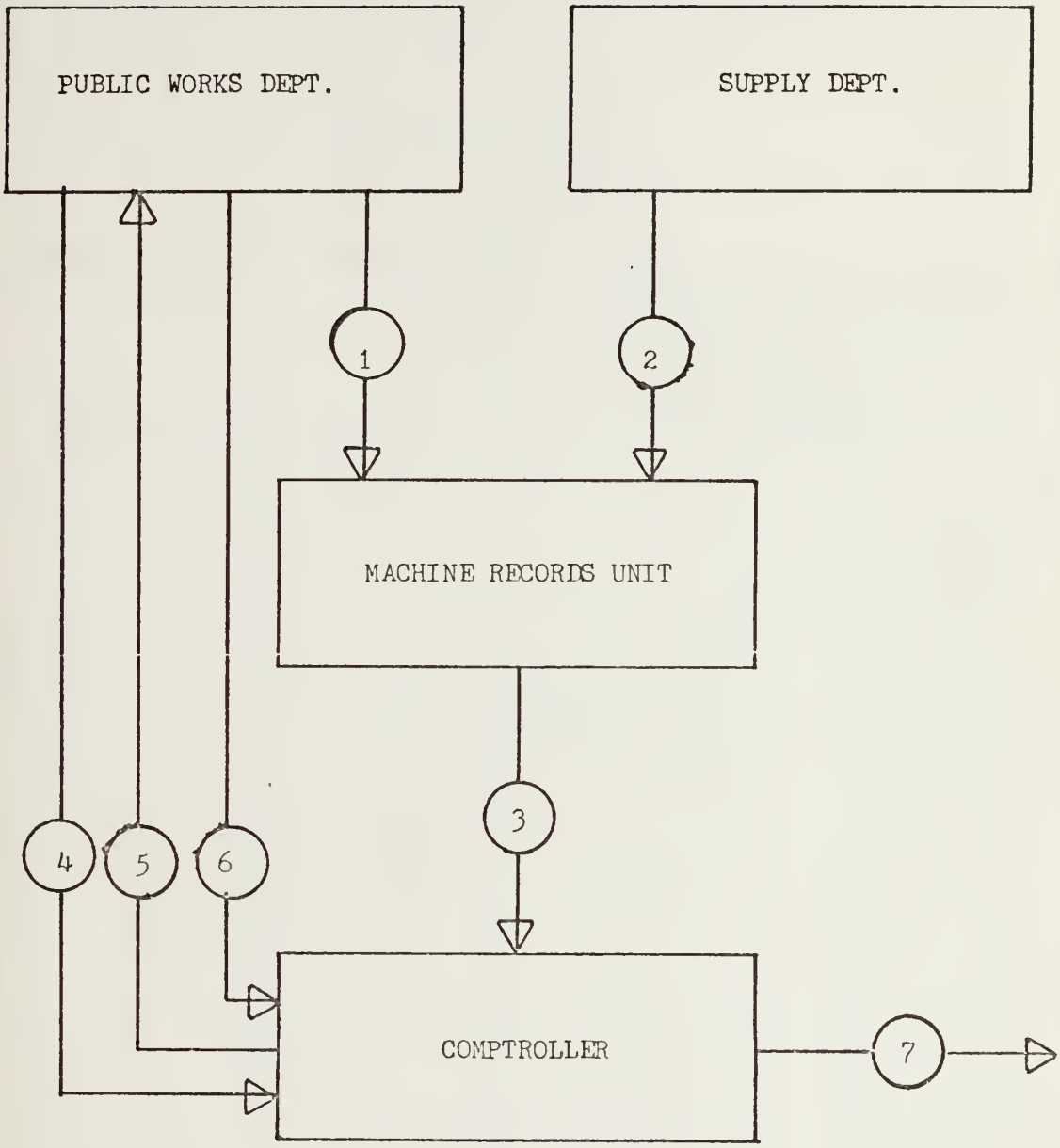


FIGURE 1: COST DATA FLOW FOR UCAR

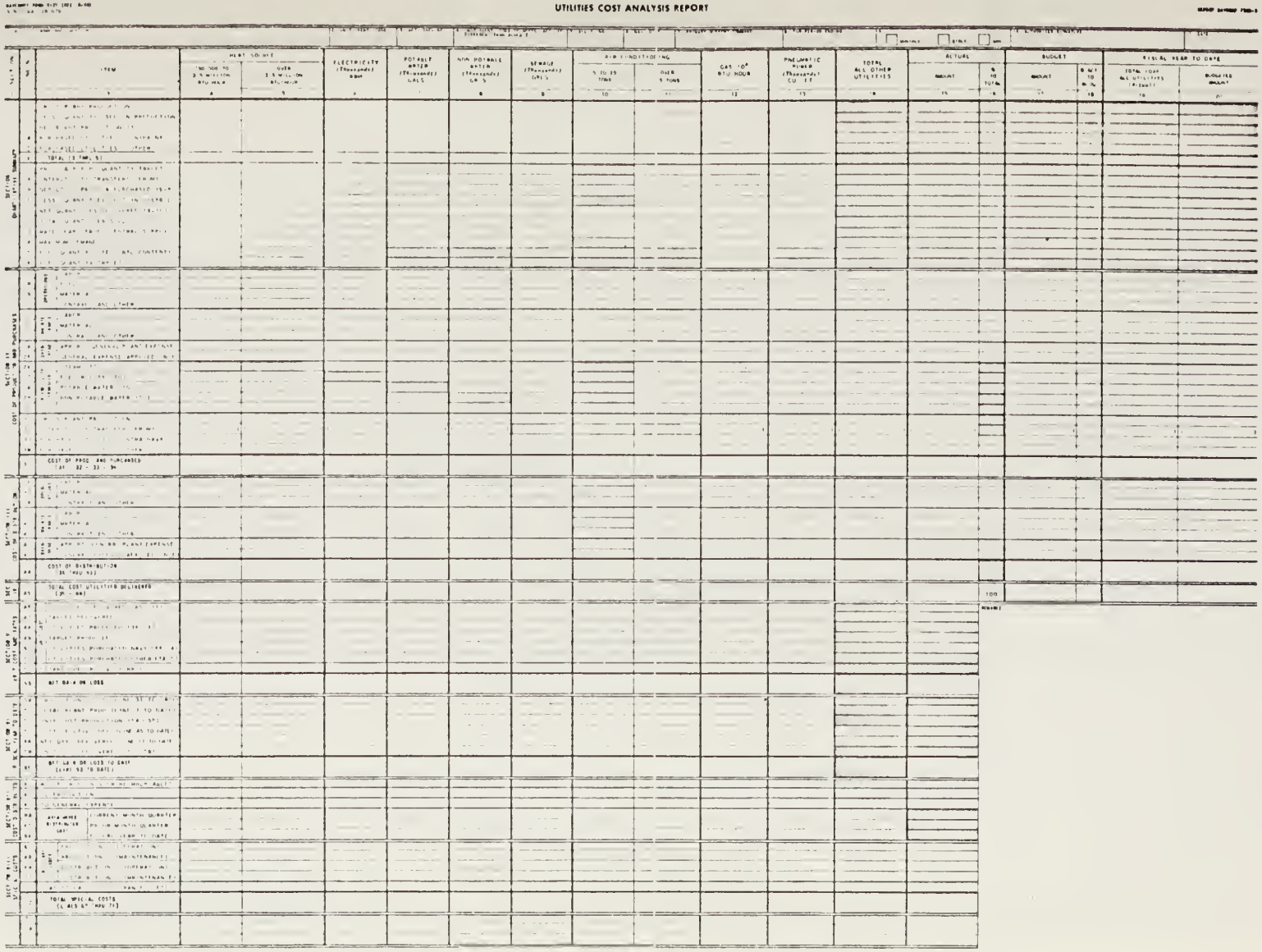


FIGURE 2: SAMPLE OF UTILITIES COST ANALYSIS REPORT

NAVCOMPT FORM 2126 (6-64)

UTILITIES FEEDER DATA REPORT

NAVCOMPT 7300-2

ACTIVITY

MONTH OR QUARTER ENDING

SECTION I - QUANTITATIVE INFORMATION

LINE	ITEM	TELEPHONES	HEATING PLANTS: 750,000 TO 3.5 MILLION BTU/HOUR (10^6 BTU)	HEATING PLANTS: OVER 3.5 MILLION BTU/HOUR (10^6 BTU)	ELECTRICITY (M KWH)	POTABLE WATER (M GALS.)	SEWAGE (THOUSANDS) GALS.						TOTAL ALL OTHER UTILITIES
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1	GROSS PLANT PRODUCTION												
2	LESS: QUANTITIES USED IN PRODUCTION												
3	NET PLANT PRODUCTION (1 - 2)												
4	PURCHASED UTILITIES												
5	TOTAL NET PRODUCTION AND PURCHASES (3 + 4)												
6	PRODUCTION AND PURCHASED QUALITY TARGET												
7	INTERUTILITY TRANSFERS												
8	NET UTILITIES PRODUCTION AND PURCHASES (5 - 7)												
9	LESS: QUANTITIES LOST IN DISTRIBUTION												
10	NET QUANTITIES DELIVERED (8 - 9)												
12	RATED CAP. PROD. PLT./CENTRAL SUPPLY POINT												
13	MAXIMUM DEMAND												
14	INVENTORY QUANTITY OF DISTRIBUTION SYSTEM												

SECTION II - COST OF INTERUTILITY TRANSFERS

26	STEAM	A. QUANTITY												
		B. MULTIPLIED BY UNIT COST (10^6 BTU)												
		C. COST PER UTILITY		( )	( )									
27	ELECTRICITY	A. QUANTITY												
		B. MULTIPLIED BY UNIT COST (M KWH)												
		C. COST PER UTILITY				( )								
28	WATER	A. QUANTITY												
		B. MULTIPLIED BY UNIT COST (M GALS)												
		C. COST PER UTILITY					( )							

SECTION V - UNIT COSTS AND RATES

43	UNIT COST TARGET DELIVERED													
45	UNIT COST TARGET PRODUCED													

14 STATISTICAL DATA ON FUEL

FUEL TYPE	GRADE	UNITS	B.T.U.'S PER UNIT	UNIT COST	QUANTITIES USED (IN B.T.U.'S)											
TOTALS																

FIGURE 3: SAMPLE OF UTILITIES FEEDER DATA REPORT

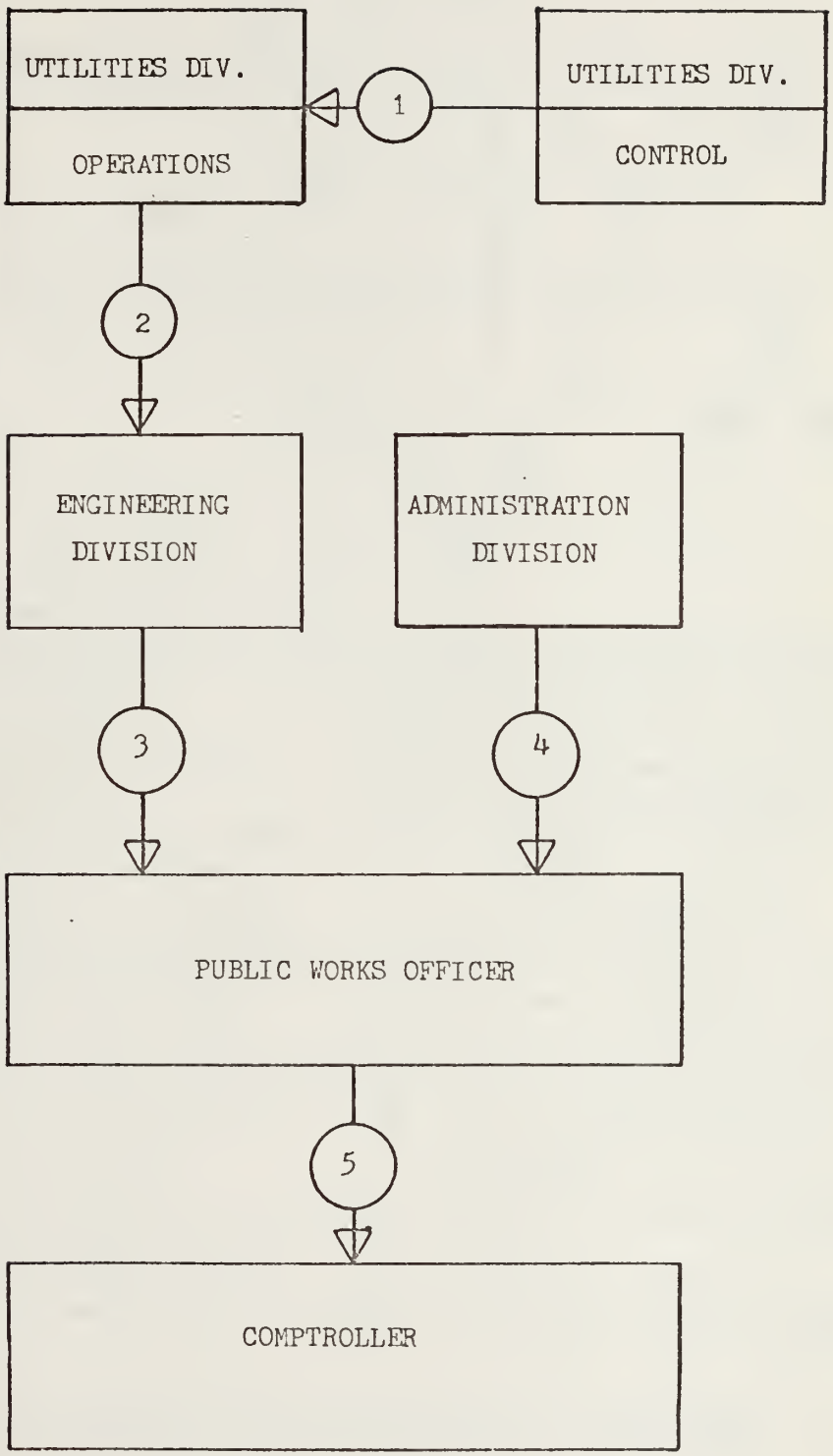
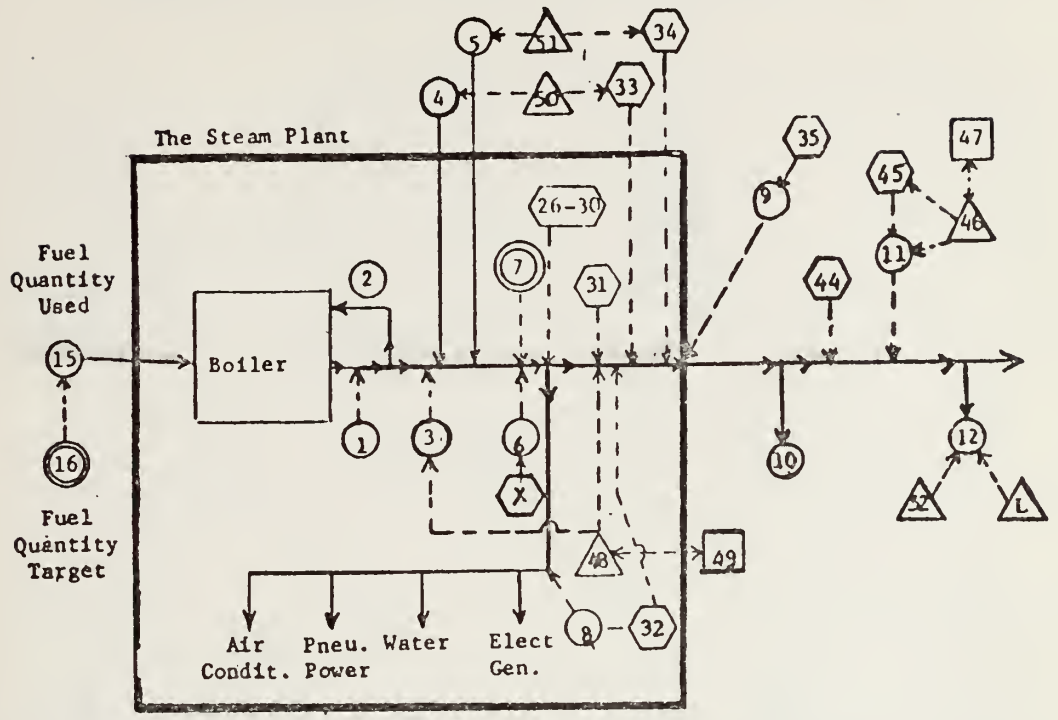


FIGURE 4: UTILITIES DATA FLOW WITHIN PUBLIC WORKS DEPT.

CHARTING OF UCAR LINE ITEMS FOR A TYPICAL STEAM PLANT



QUANTITIES · QUANTITY TARGET · COSTS · UNIT COSTS · UNIT COST TARGETS

1. Gross Plant Production
2. Quantities Used In Production
3. Net Plant Production
4. Purchased Utilities--Intra Navy
5. Purchased Utilities--Other
6. Total Production and Purchases
7. Production and Purchases Quantity Target (Compared with 6)
8. Interutility Transfer (FROM)
9. Net Utilities Produced and Purchased
10. Quantities Lost in Distribution
11. Net Quantities Delivered
12. Total Quantities Sold
X. Total Unadjusted Costs (17 thru 25)
26-30. Interutility Transfer Costs (TO)
31. Gross Plant Production Cost
32. Interutility Transfer Costs (FROM)
33. Purchased Utility Costs-Intra Navy
34. Purchased Utility Costs-Other
35. Total Cost of Production and Purchases
44. Total Cost of Distribution (Lines 36 thru 43)
45. Total Cost of Utilities Delivered
46. Unit Cost of Utilities Delivered
47. Unit Cost Target Delivered
48. Unit Cost of Utilities Produced
49. Unit Cost Target Produced
50. Unit Cost of Utilities Purchased-Intra Navy
51. Unit Cost of Utilities Purchased-Other
52. Established Activity Rate
L. Local Prevailing Rate or Private Party Rate

FIGURE 5: RELATION OF UCAR LINE ITEMS TO A STEAM PLANT

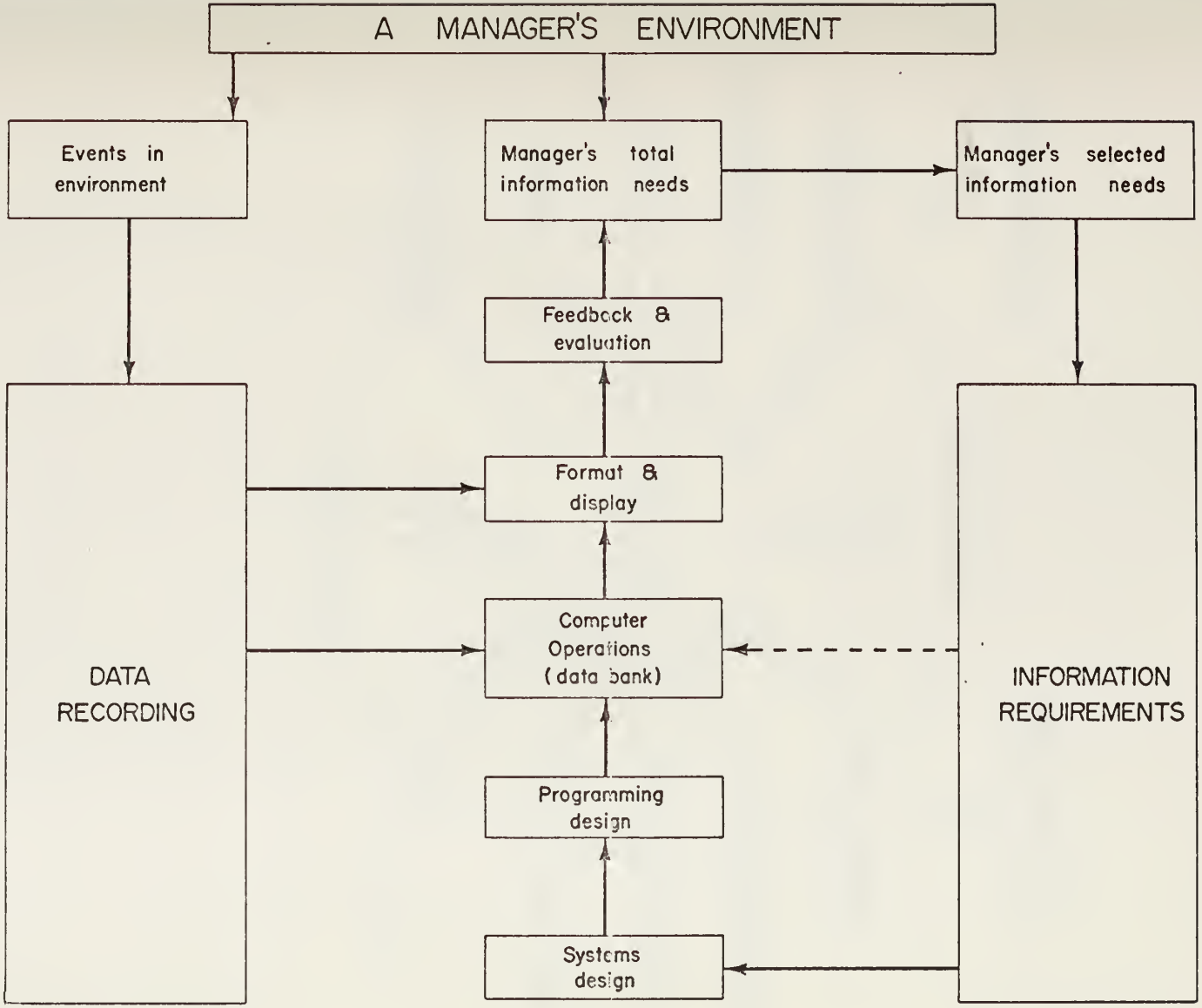


FIGURE 6: GENERALIZED DIAGRAM OF A MANAGEMENT INFORMATION SYSTEM

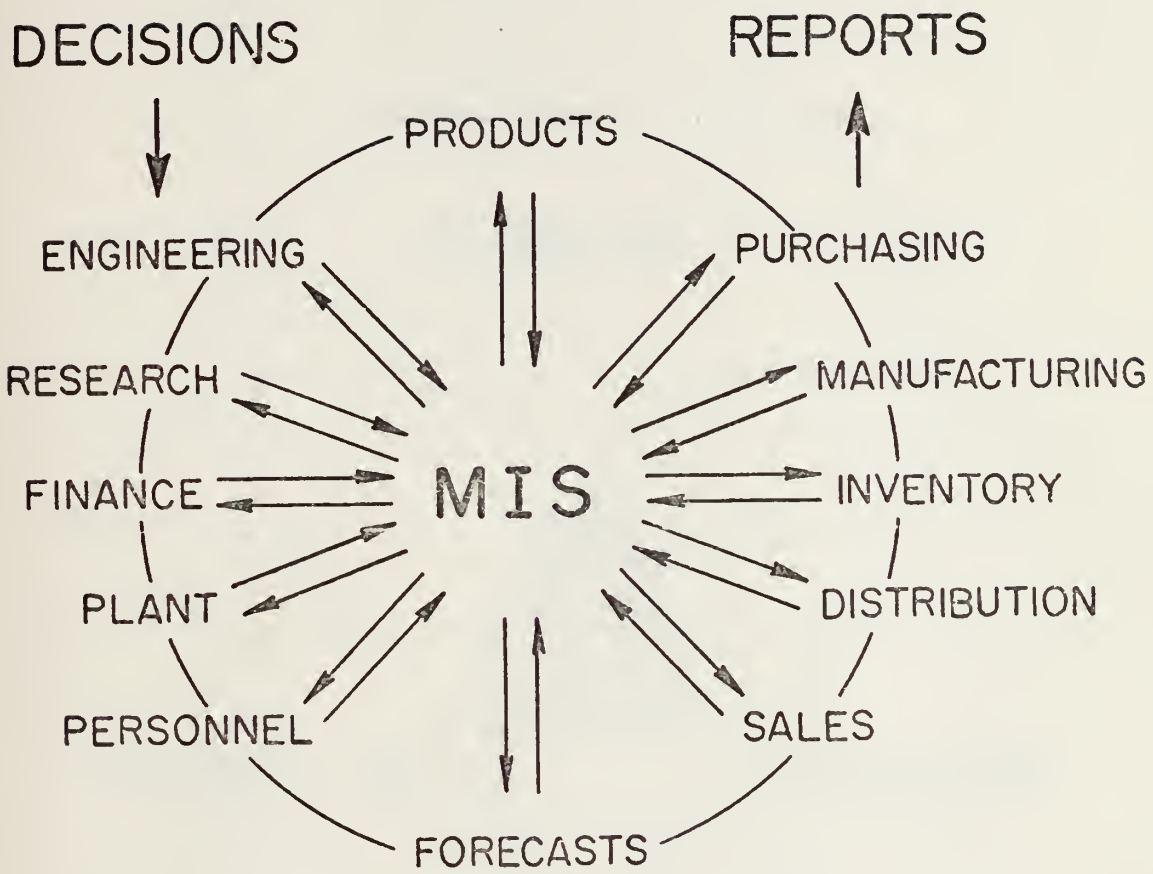


FIGURE 7: INFORMATION FLOW WITHIN AN MIS

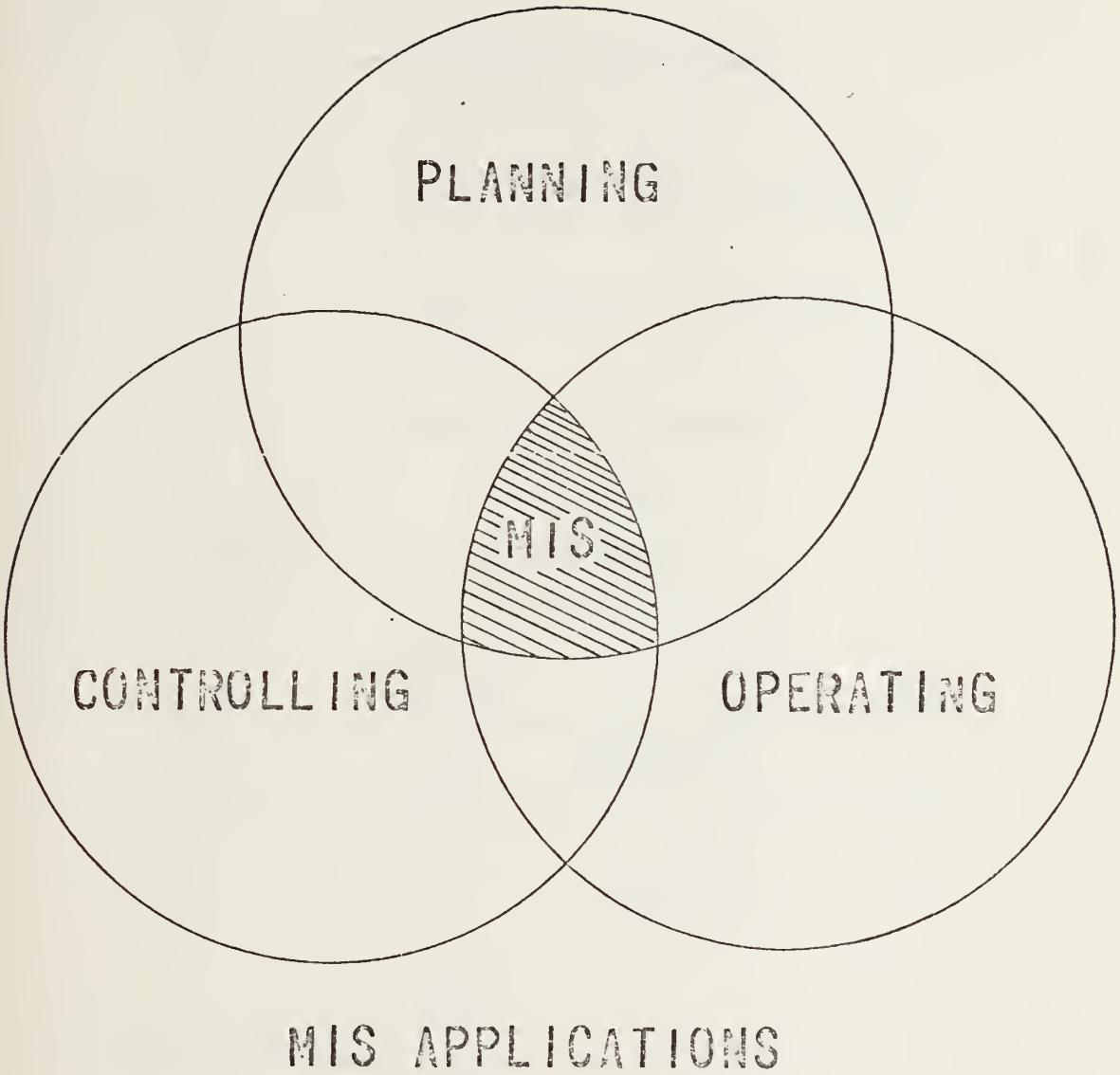


FIGURE 8: MIS INTERFACE WITH MANAGEMENT FUNCTIONS

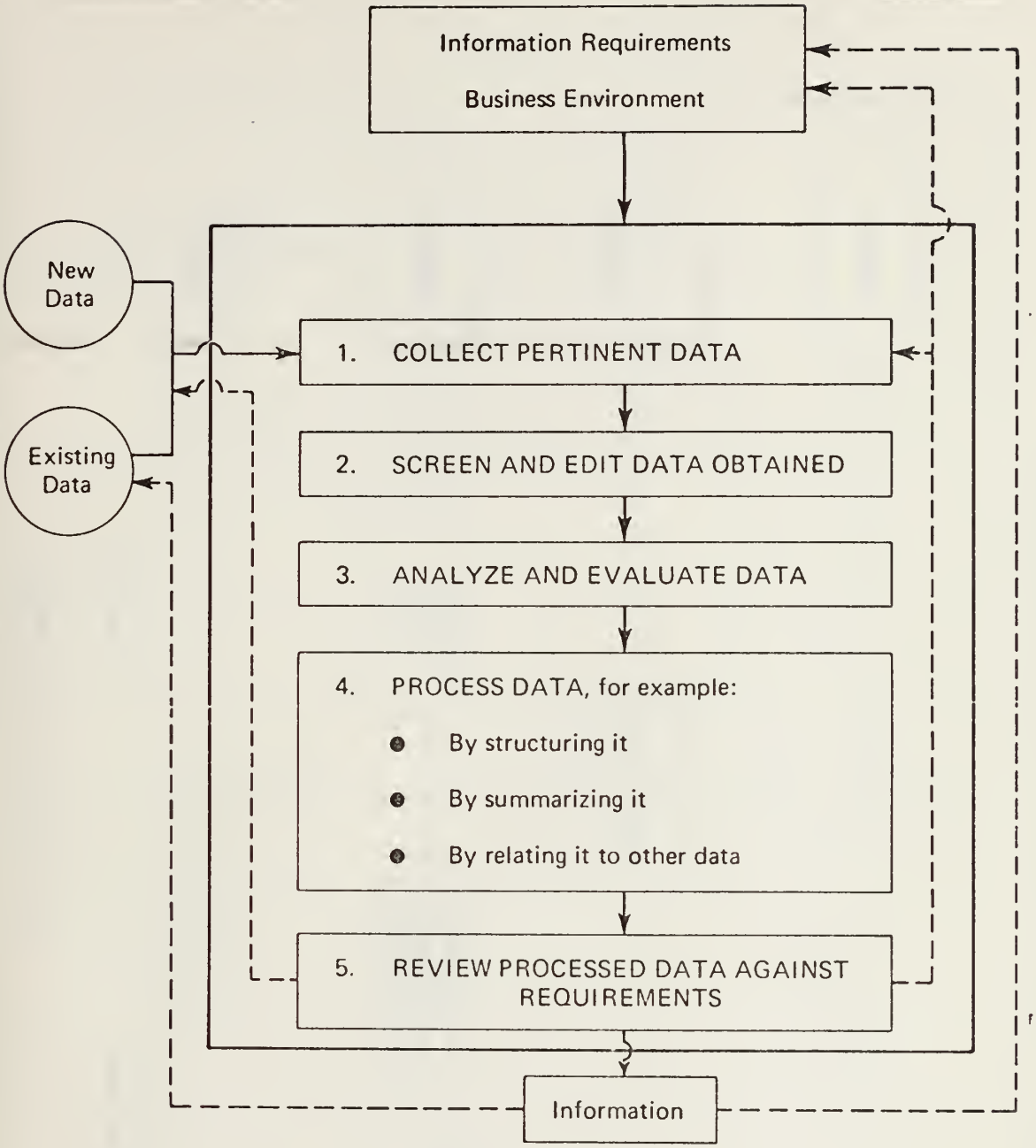


FIGURE 9: ELEMENTS OF THE INFORMATION PRODUCTION PROCESS

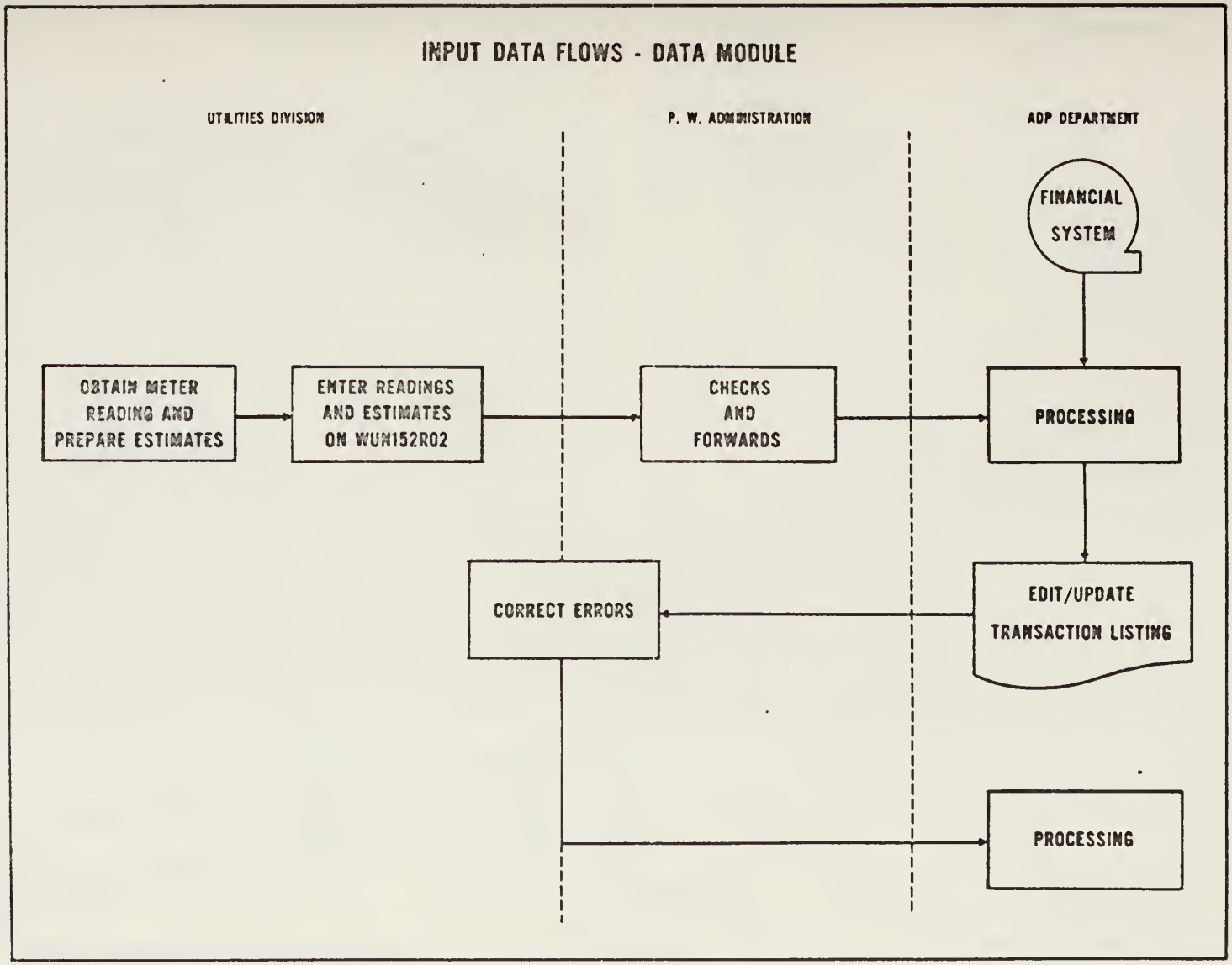


FIGURE 10: FLOW OF INPUT DATA WITHIN THE DATA MODULE

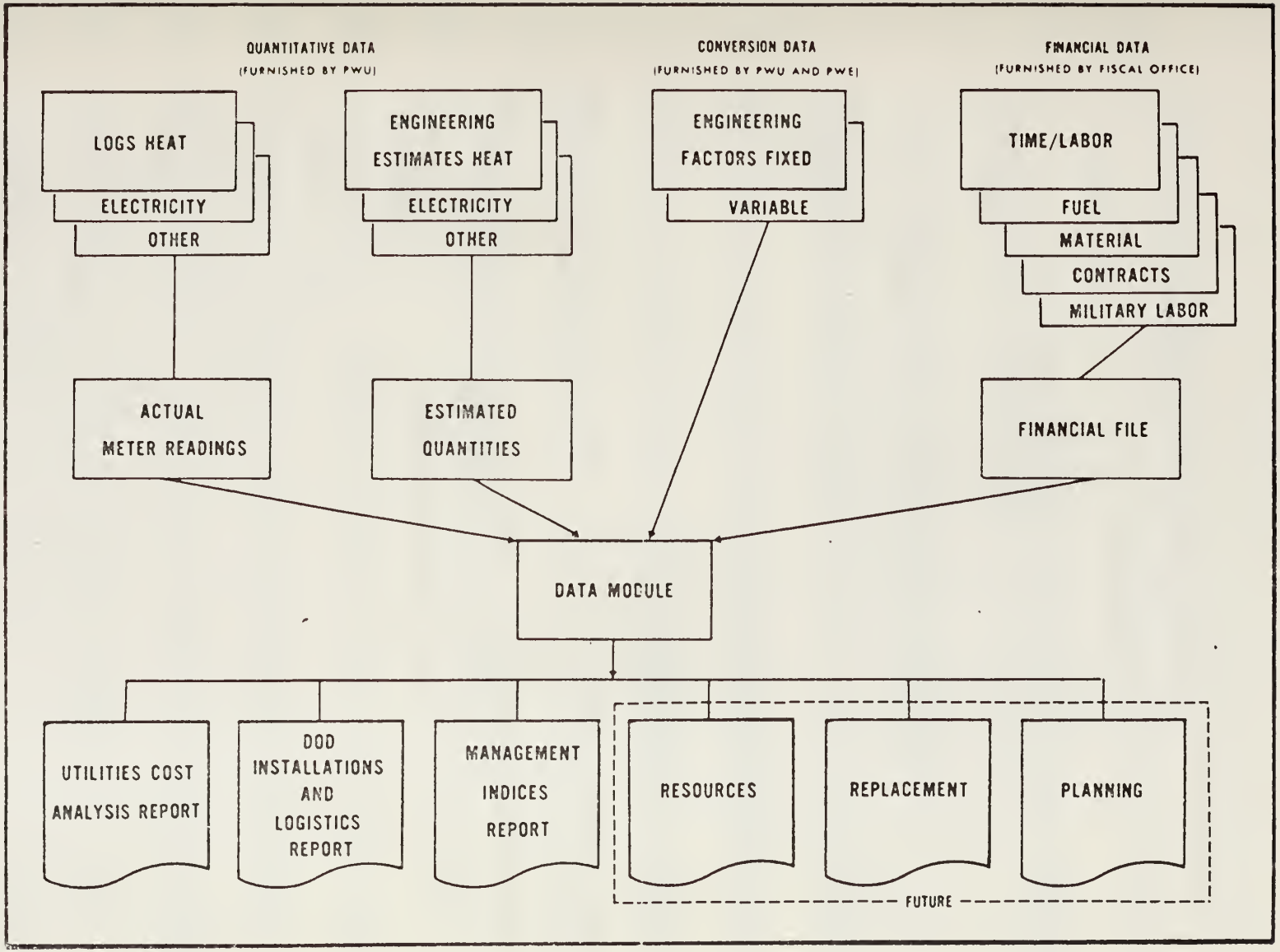


FIGURE 11: INPUTS AND OUTPUTS OF DATA MODULE

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